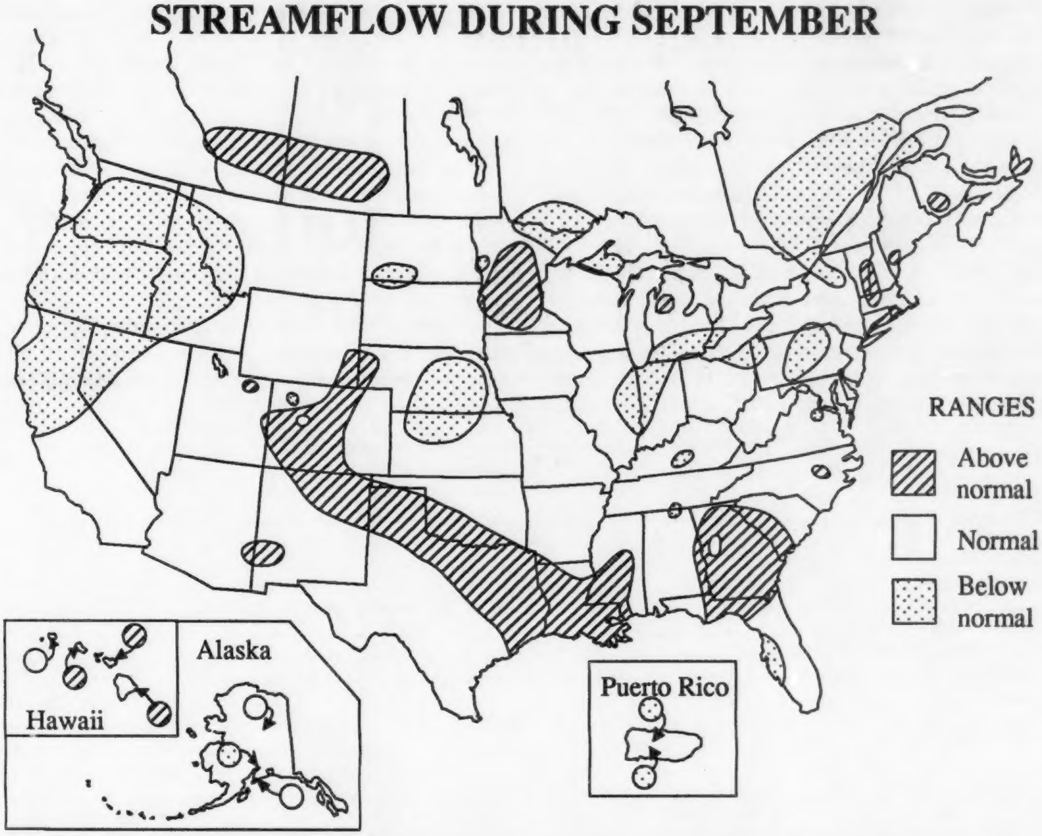
National Water Conditions

UNITED STATES
Department of the Interior
Geological Survey

CANADA
Department of the Environment
Water Resources Branch

SEPTEMBER 1991

STREAMFLOW DURING SEPTEMBER



Drought continued to affect parts of the conterminous United States and southern Canada, with streamflow at September lows in parts of Oregon and Kansas, reservoir contents low in California and New York, and many new September lows at ground-water index stations.

Streamflow was in the normal to above-normal range at 77 percent of the index stations in the United States, southern Canada, and Puerto Rico. Below-normal range streamflow occurred in 16 percent of the area of the conterminous United States and southern Canada during September. Total September flow for the reporting index stations in the conterminous United States and southern Canada was 3 percent above median, despite decreasing by 22 percent from last month, and 7 percent more than flow during September 1990.

The combined flow of the 3 largest rivers in the lower 48 States--Mississippi, St. Lawrence, and Columbia--averaged 9 percent below median and in the normal range.

Mean September elevations at four master gages on the Great Lakes (provisional National Ocean Service data) were below median on all of the lakes, and also in the below-normal range on Lake Superior and Lake Ontario.

Utah's Great Salt Lake fell 0.20 foot during September, finishing the month at 4,201.50 feet above National Geodetic Vertical Datum (NGVD) on September 30.

Streamflow was above median in the Florida and Gulf of Mexico, Upper Mississippi River, Southern Great Plains and Rio Grande, and Colorado River basins, and below median in the other 8 basins. September streamflow declined from that for August in all areas except in the Hudson Bay, Upper Mississippi River, Southern Great Plains and Rio Grande, and Colorado River basins.

SURFACE-WATER CONDITIONS DURING SEPTEMBER 1991

Streamflow declined (generally seasonally) at 123 index stations, remained unchanged at 2 stations, and increased at 65 stations during September. The contents of the New York City Reservoir System continued to decline and were at only 52 percent of capacity (69 percent of the long-term average) for the end of September. In California (see graphs on pages 6-7), total streamflow for September at the six index stations in California was 22 percent below median. The persistence and severity of the drought in California is shown by the following: (1) since the end of September 1990 (the most recent month of above-median streamflow), the cumulative streamflow deficit at the six index stations has gone from about 68 percent of a median year of runoff to about 111 percent of a median year of runoff—about 43 percent of a median year of runoff was "lost" in the last 12 months; and (2) the seasonal lows in combined storage for six large index reservoirs have generally declined steadily since 1986, bottoming out at 69, 53, 43, 45, and 33 percent of capacity, with combined storage currently at 34 percent of capacity.

Streamflow was in the normal to above-normal range at 77 percent of the index stations in the United States, southern Canada, and Puerto Rico during September, compared with 75 percent of stations in those ranges during August, and 74 percent of stations in those ranges during September 1990. Below-normal range streamflow occurred in 16 percent of the area of the conterminous United States and southern Canada during September, compared with 22 percent during August, and 25 percent during September 1990. Total September flow of 371,100 cubic feet per second (cfs) for the 172 reporting index stations in the conterminous United States and southern Canada was 3 percent above median, despite decreasing by 22 percent from last month, and 7 percent more than flow during September 1990. (Data for the English River at Umfreville, Ontario, and the Saugeen River near Port Elgin, Ontario, were not available.)

Five new extremes—3 lows and 2 highs (table on page 4)—occurred at streamflow index stations, compared with 4 lows (including one all-time) and 2 highs during August. The lows occurred at stations in Kansas (2) and Oregon, while the two highs occurred at stations in Minnesota and Oklahoma. Hydrographs for the five stations at which new extremes occurred are on page 5. The other two hydrographs at the bottom of page 5 are for the Apalachicola River at Chattahoochee, Florida, at which the monthly mean was 61 percent above median and the second highest of record for September, and the Pecos River near Pecos, New Mexico, at which the monthly mean was 318 percent above median and also the second highest of record for September.

The combined flow of the 3 largest rivers in the lower 48 States—Mississippi, St. Lawrence, and Columbia—averaged 581,100 cfs; 9 percent below median and in the normal range, despite a 17 percent

(Continued on page 4)

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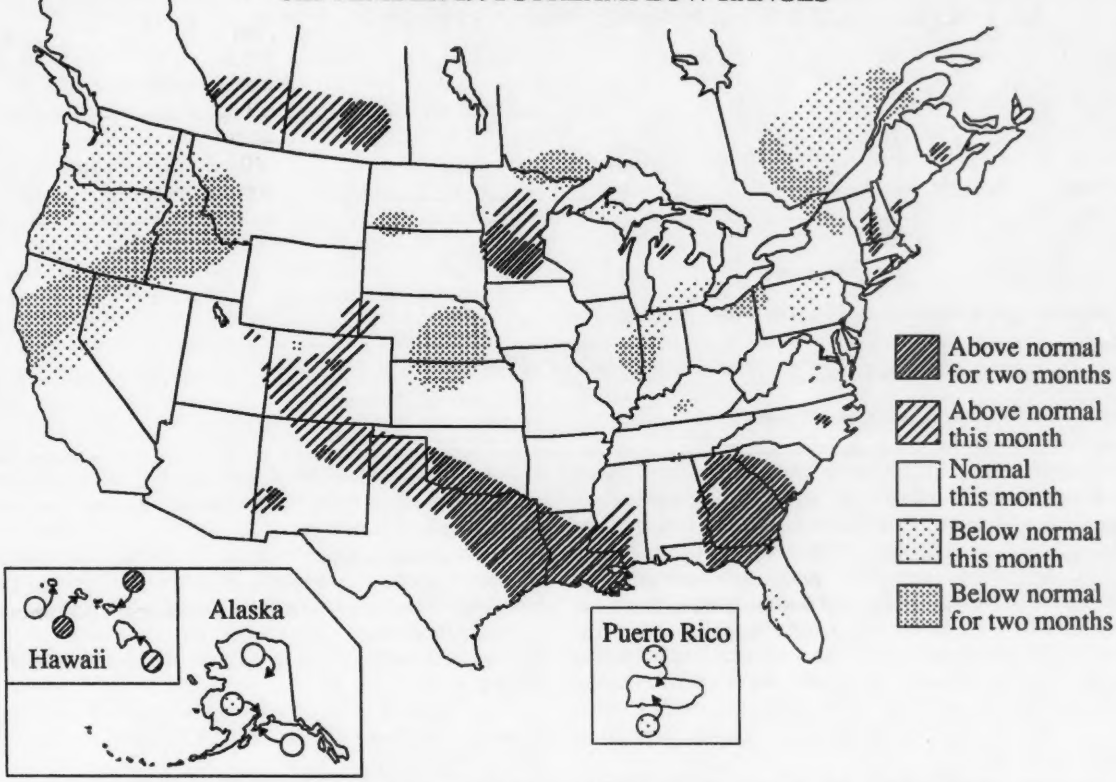
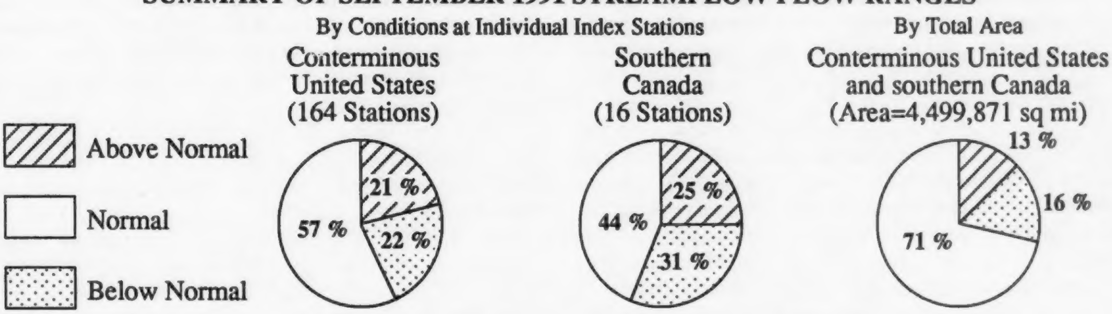
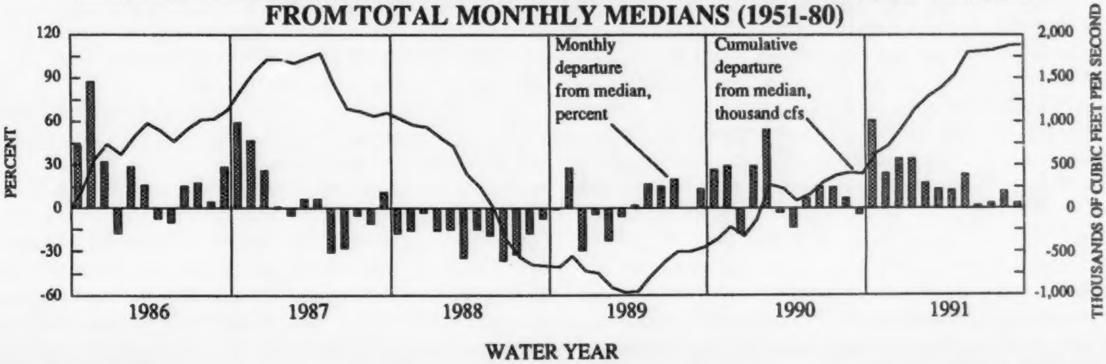
SEPTEMBER 1991 STREAMFLOW RANGES



SUMMARY OF SEPTEMBER 1991 STREAMFLOW FLOW RANGES



MONTHLY AND CUMULATIVE DEPARTURE OF TOTAL MONTHLY MEANS FROM TOTAL MONTHLY MEDIANS (1951-80)



NEW EXTREMES DURING SEPTEMBER 1991 AT STREAMFLOW INDEX STATIONS

Station number	Stream and place of determination	Drainage area (square miles)	Years of record	Previous September extremes (period of record): Monthly mean in cfs (year)	Previous September extremes (period of record): Daily mean in cfs (year)	September 1991: Monthly mean in cfs	September 1991: Percent of median	September 1991: Daily mean in cfs	September 1991: Day
				LOW FLOWS					
06867000	Saline River near Russell, Kansas	1,502	39	1.55 (1983)	0.16 (1986)	0.83	2	0.35	12
06884400	Little Blue River near Barnes, Kansas	3,324	32	64.5 (1980)	48.0 (1988)	49.2	10	33.0	20
14191000	Willamette River (adjusted) at Salem, Oregon	7,280	74	2,482 (1990)	2,500 (1931)	1,892	47	7,020	3
				HIGH FLOWS					
05280000	Crow River at Rockford, Minnesota	2,520	65	2,880 (1957)	5,700 (1986)	4,909	2,160	8,570	18
07331000	Washita River near Dickson, Oklahoma	7,202	62	4,271 (1945)	38,500 (1945)	5,131	1,410	14,000	17

decrease in flow from August to September. Flow of the St. Lawrence River was in the normal range for the fourth consecutive month. Flow of the Mississippi River was in the normal range for the third consecutive month after being in the above-normal range during May and June. Flow of the Columbia River was in the below-normal range after an above-normal range August, which was preceded by eight consecutive months in the normal range. Hydrographs for both the combined and individual flows of the "Big 3" are on page 8. Dissolved solids and water temperatures at four large river stations are also given on page 8. Flow data for the "Big 3" and 42 other large rivers are given in the Flow of Large Rivers table on page 9.

Month-end index reservoir contents were in the below-average range (below the month-end average for the period of record by more than 5 percent of normal maximum contents) at 29 of 99 reporting sites (data were not available for the Nova Scotia system), compared with 34 of 99 at the end of August, and 40 of 100 at the end of September 1990, including most reservoirs in New York, New Jersey, Maryland, Nebraska, North Dakota, Montana, Wyoming, Utah, Nevada, and California. Contents were in the above-average range at 41 reservoirs (compared with 31 last month), including most reservoirs in New Hampshire, the Carolinas, Georgia, Alabama, the Tennessee Valley, Wisconsin, Minnesota, Oklahoma, Texas, and Arizona. Reservoirs with contents in the below-average range and significantly lower than last year (with normal maximum contents of at least 1,000,000 acre-feet) are: the New York City Reservoir System, New York; Allegheny, Pennsylvania; Boise River, Idaho; and Clair Engle Lake and Shasta Lake, California. Four reservoirs had less than 10 percent of normal maximum contents (September average in parentheses): John Martin, Colorado, 2 percent (16); Pine Flat, California 3 percent (36); Lake Tahoe, California-Nevada, 0 percent (53); and Rye Patch, Nevada, 1 percent (51). Graphs of contents for seven reservoirs are on page 10 with contents for the 99 reporting reservoirs given on page 11. Maps on page 13 show reservoir storage conditions for September 1991 and September 1990 on the streamflow maps for those months.

Mean September elevations at four master gages on the Great Lakes (provisional National Ocean Service data) were below median on all of the lakes, and also in the below-normal range on Lake Superior and Lake Ontario. Levels fell from those for August on all the lakes. September levels ranged from 0.05 (Lake Superior) to 0.70 foot (Lake Ontario) lower than those for August. Monthly means have now been in the normal range for 6 months on Lake Erie and 16 months on Lake Huron, while the below-normal range means on Lake Superior and Lake Ontario follow 7 months and 5 months of normal range means, respectively. September 1991 levels ranged from 0.42 foot lower (Lake Erie) to 0.24 foot higher (Lake Superior) than those for September 1990. Stage hydrographs for the master gages on Lake Superior, Lake Huron, Lake Erie, and Lake Ontario are on page 12.

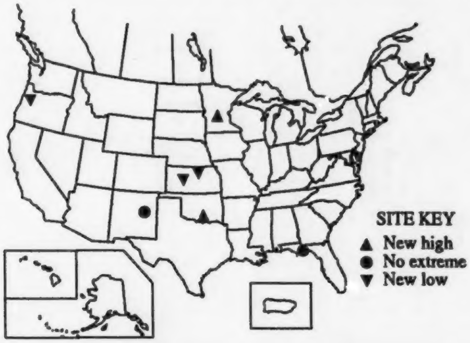
Utah's Great Salt Lake (graph on page 12) fell 0.20 foot during September, finishing the month at 4,201.50 feet above National Geodetic Vertical Datum (NGVD) on September 30. Lake level was 1.10 foot lower than at the end of September 1990, and 10.35 feet lower than the maximum of record which occurred in June 1986 and March-April 1987. (***Note: The elevation of 4,202.70 feet above NGVD cited for August 31 in last months newsletter was the result of incorrect information. The actual monthend elevation was 4,201.70 feet above NGVD.***)

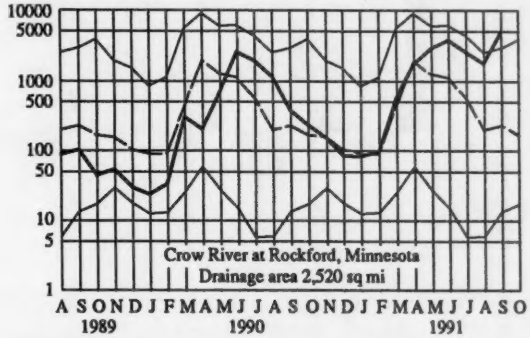
Maps on page 13 show streamflow conditions for September 1991 and September 1990. September 1991 has about 44 percent more area in the above-normal range, 36 percent less area in the below-normal range, and about 8 percent more area in the normal range than September 1990. Below-normal range streamflow occurred in parts of Washington, Oregon, California, Nevada, Idaho, Montana, North Dakota, Minnesota, Nebraska, Kansas, Florida, New York, and Quebec during both months. Above-normal range streamflow occurred in parts of Saskatchewan, New Brunswick, Vermont, Minnesota, Wisconsin, Oklahoma, Texas, and Colorado during both months. Both maps also show reservoir storage conditions at all index reservoir stations for comparison with streamflow.

Graphs for 12 hydrologic areas show monthly percent departure of streamflow from median for the 1986-91 water years to date (page 14) and also compare monthly streamflow for the 1990 and 1991 water years with median monthly streamflow for 1951-80 (page 15). Streamflow was above median in the Florida and Gulf of Mexico, Upper Mississippi River, Southern Great Plains and Rio Grande, and Colorado River basins, and below median in the other 8 basins. September streamflow declined from that for August in all areas except in the Hudson Bay, Upper Mississippi River, Southern Great Plains and Rio Grande, and Colorado River basins.

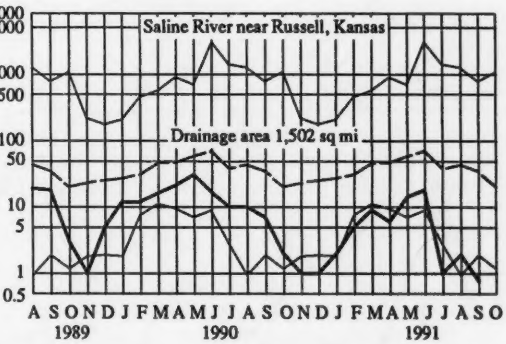
MONTHLY MEAN DISCHARGE OF SELECTED STREAMS

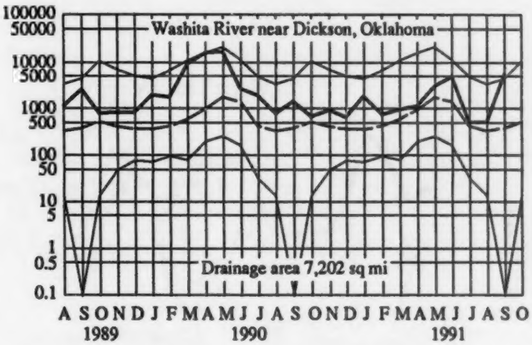
Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period.

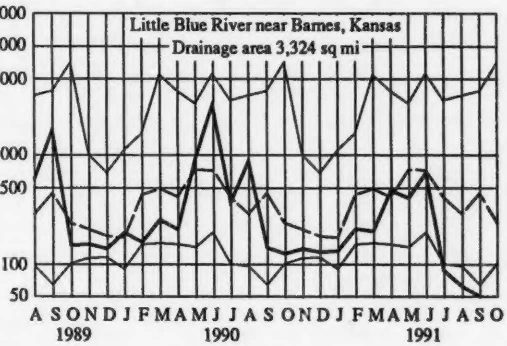


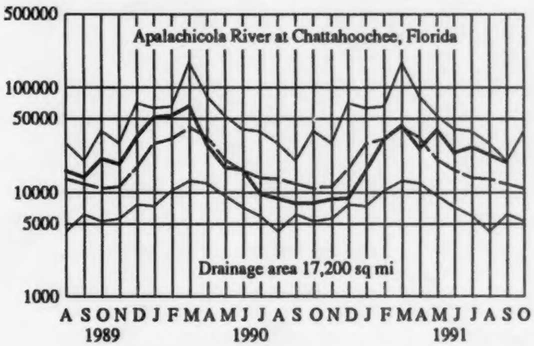


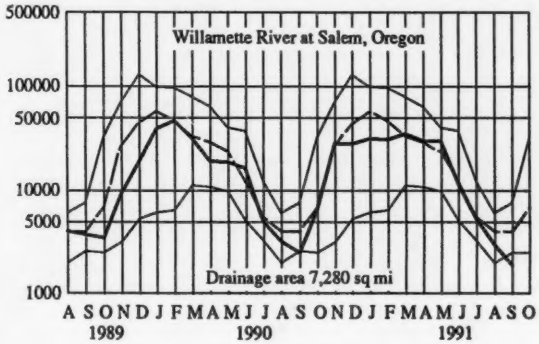
DISCHARGE IN CUBIC FEET PER SECOND

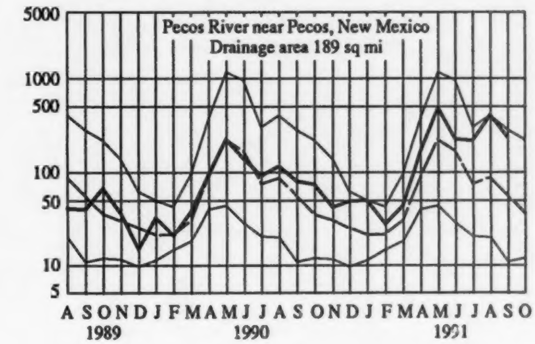


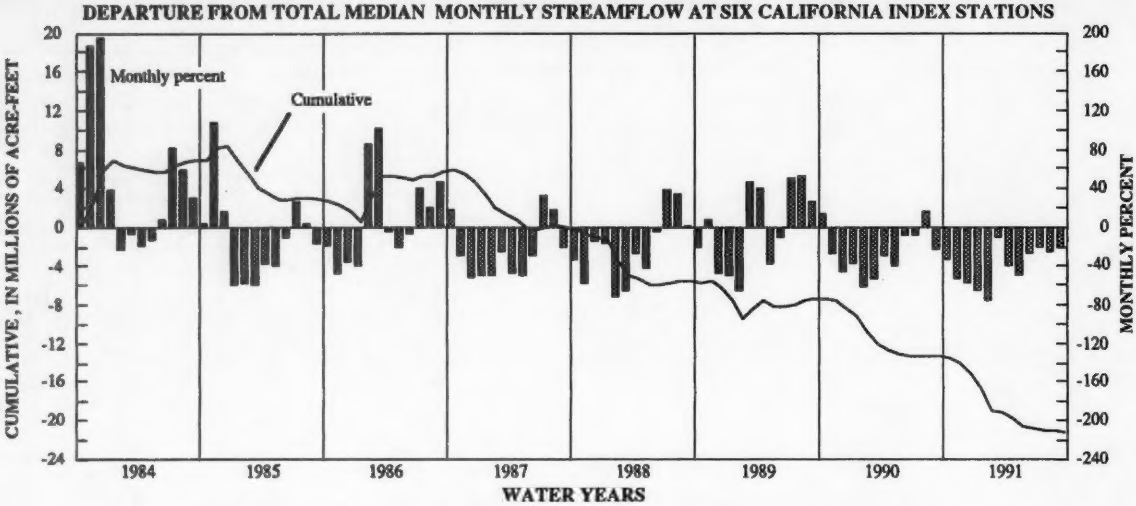


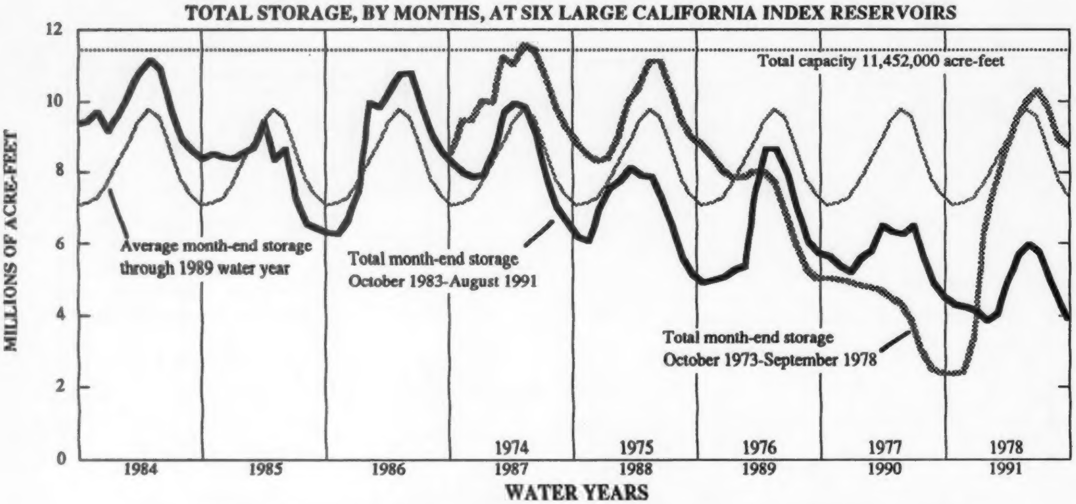


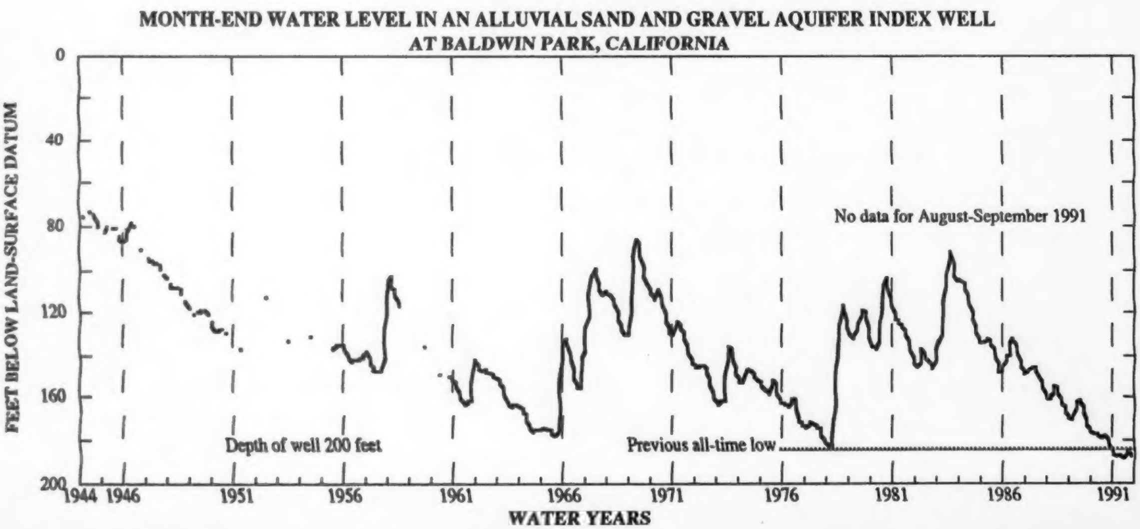




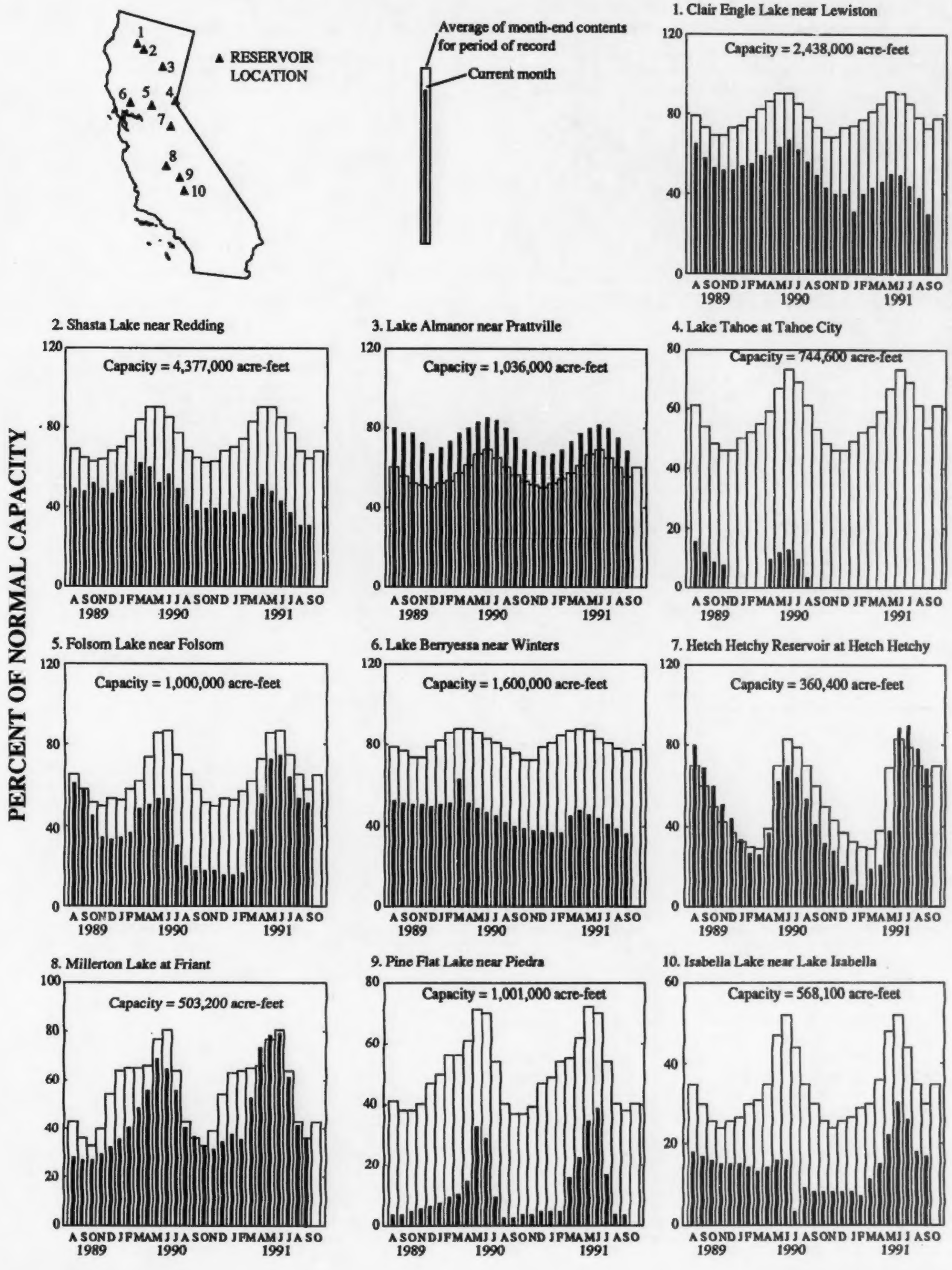



DEPARTURE FROM TOTAL MEDIAN MONTHLY STREAMFLOW AT SIX CALIFORNIA INDEX STATIONS
Monthly percent
Cumulative
CUMULATIVE, IN MILLIONS OF ACRE-FEET
MONTHLY PERCENT
WATER YEARS
1984
1985
1986
1987
1988
1989
1990
1991


TOTAL STORAGE, BY MONTHS, AT SIX LARGE CALIFORNIA INDEX RESERVOIRS
Total capacity 11,452,000 acre-feet
Average month-end storage through 1989 water year
Total month-end storage October 1983-August 1991
Total month-end storage October 1973-September 1978
MILLIONS OF ACRE-FEET
WATER YEARS

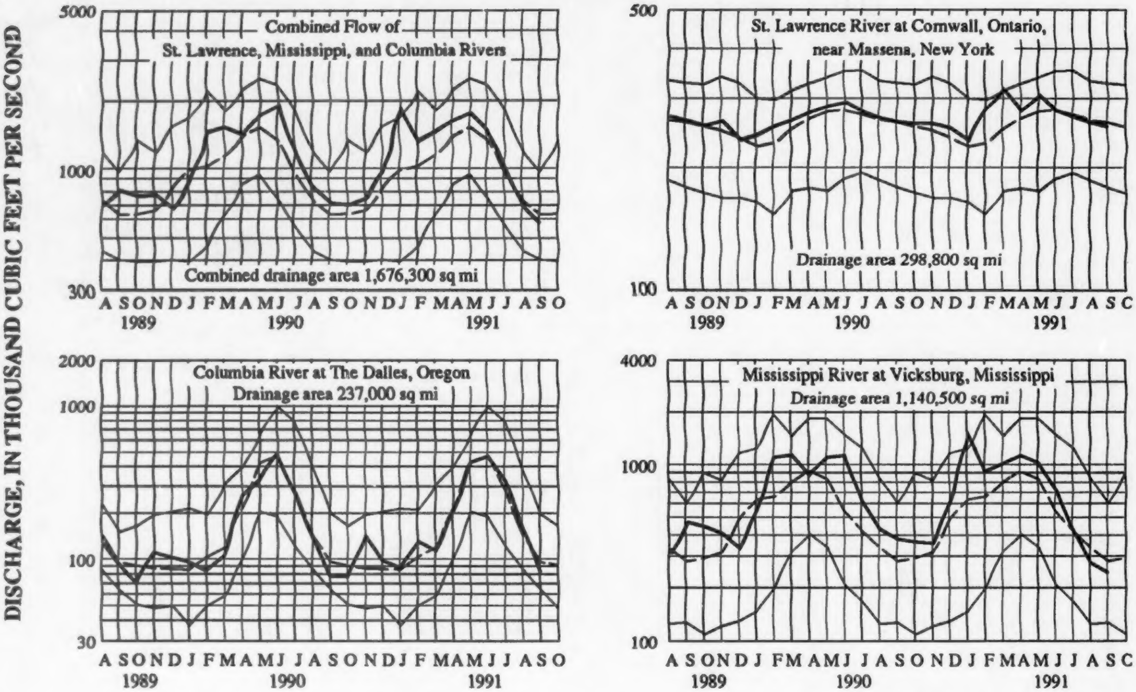

MONTH-END WATER LEVEL IN AN ALLUVIAL SAND AND GRAVEL AQUIFER INDEX WELL AT BALDWIN PARK, CALIFORNIA
No data for August-September 1991
Depth of well 200 feet
Previous all-time low
FEET BELOW LAND-SURFACE DATUM
WATER YEARS

CALIFORNIA RESERVOIR INDEX STATIONS



HYDROGRAPHS FOR THE "BIG THREE" RIVERS

Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period.



Provisional data; subject to revision

DISSOLVED SOLIDS AND WATER TEMPERATURES, FOR SEPTEMBER 1991, AT DOWNSTREAM SITES ON FIVE LARGE RIVERS

Station number	Station name	September data of following calendar years	Stream discharge during month: Mean (cfs)	Dissolved-solids concentration[1]: Minimum (mg/L)	Dissolved-solids concentration[1]: Maximum (mg/L)	Dissolved-solids discharge[1]: Mean (tons per day)	Dissolved-solids discharge[1]: Minimum (tons per day)	Dissolved-solids discharge[1]: Maximum (tons per day)	Water temperature[2]: Mean in °C	Water temperature[2]: Minimum in °C	Water temperature[2]: Maximum in °C
01463500	Delaware River at Trenton,	1991	3,232	104	129	1,054	851	1,956	22.5	17.0	26.0
	New Jersey, (Morrisville,	1945-90	5,876	63	149	[3]2,056	523	11,730	[3]21.0	14.0	32.0
	Pennsylvania)	(Extreme yr)		(1977)	(1965)		(1966)	(1987)			
			[4]4,272								
07289000	Mississippi River at	1991	243,800	247	273	171,500	155,800	191,800	28.0	22.5	30.5
	Vicksburg, Mississippi	1976-90	340,900	185	309	244,400	116,000	472,000	26.0	21.0	30.0
		(Extreme yr)		(1977)	(1987)		(1976)	(1979)			
			[4]281,700								
03612500	Ohio River at lock and dam 53,	1991	78,650	123	197	...	22,200	57,200	...	22.5	27.0
	near Grand Chain, Illinois,	1955-90	112,300	117	320	...	9,160	304,000	...	17.0	37.0
	(streamflow station at Metropolis,	(Extreme yr)		(1965)	(1990)		(1961)	(1975)			
	Illinois)		[4]89,720								
06934500	Missouri River at Hermann,	1991	40,900	...	...	...	...	...	...	...	...
	Missouri. (60 miles west of	1976-90	74,860	204	525	83,260	45,000	137,000	24.5	16.0	28.5
	St. Louis, Missouri)	(Extreme yr)		(1977)	(1983)		(1989)	(1986)			
			[4]54,090								
14128910	Columbia River at Warrendale,	1991	120,000	85	91	28,000	21,400	34,000	20.0	18.5	21.0
	Oregon (streamflow station at	1976-90	170,800	73	102	27,800	16,000	50,300	19.5	12.0	22.5
	The Dalles, Oregon)	(Extreme yr)		(1976)	(1977, 1979)		(1990)	(1976)			
			[4]96,870								

[1]Dissolved-solids concentrations, when not analyzed directly, are calculated on basis of measurements of specific conductance.

[2]To convert °C to °F: [(1.8 x °C) + 32] = °F.

[3]Mean for 7-year period (1983-90).

[4]Median of monthly values for 30-year reference period, water years 1951-80, for comparison with data for current month.

Provisional data; subject to revision

FLOW OF LARGE RIVERS DURING SEPTEMBER 1991

Station number	Stream and place of determination	Drainage area (square miles)	Average discharge through September 1985 (cubic feet per second)	September 1991: Monthly mean discharge (cubic feet per second)	Percent of median monthly discharge 1951–80	Change in discharge from previous month (percent)	Discharge near end of month: Cubic feet per second	Million gallons per day	Date
01014000	St. John River below Fish River at Fort Kent, Maine	5,665	9,758	3,058	65	36	5,100	3,300	30
01318500	Hudson River at Hadley, New York	1,664	2,908	† 735	67	47	1,340	866	30
01357500	Mohawk River at Cohoes, New York	3,456	5,683	1,320	80	25	2,000	1,300	30
01463500	Delaware River at Trenton, New Jersey	6,780	11,670	3,232	76	2	3,020	1,950	30
01570500	Susquehanna River at Harrisburg, Pennsylvania	24,100	34,340	† 3,840	52	–17	5,530	3,570	29
01646500	Potomac River near Washington, District of Columbia	11,560	[1]11,500	[1]2,000	73	–22	...	...	...
02105500	Cape Fear River at William O. Huske Lock, near Tarheel, North Carolina	4,852	5,002	1,605	90	–41	...	...	...
02131000	Pee Dee River at Peedee, South Carolina	8,830	9,871	3,808	74	–69	3,870	2,500	30
02226000	Altamaha River at Doctortown, Georgia	13,600	13,730	* 9,989	201	–46	4,000	2,600	30
02320500	Suwannee River at Branford, Florida	7,880	6,986	* 11,810	235	–43	7,060	4,560	30
02358000	Apalachicola River at Chattahoochee, Florida	17,200	22,420	* 19,070	162	–15	16,600	10,700	30
02467000	Tombigbee River at Demopolis lock and dam, near Coatopa, Alabama	15,385	23,520	5,086	132	–1	4,200	2,710	29
02489500	Pearl River near Bogalusa, Louisiana	6,573	9,880	* 4,722	208	17	6,620	4,280	30
03049500	Allegheny River at Natrona, Pennsylvania	11,410	[1]19,580	[1]3,010	75	15	3,420	2,210	27
03085000	Monongahela River at Braddock, Pennsylvania	7,337	[1]12,480	[1]2,167	67	–2	1,660	1,070	27
03193000	Kanawha River at Kanawha Falls, West Virginia	8,367	12,550	3,849	115	18	3,980	2,570	29
03234500	Scioto River at Higby, Ohio	5,131	4,583	601	57	–18	475	306	30
03294500	Ohio River at Louisville, Kentucky[2] #	91,170	115,800	26,220	113	0	24,430	15,790	29
03377500	Wabash River at Mount Carmel, Illinois	28,635	27,660	† 4,091	60	–17	3,810	2,460	30
03469000	French Broad River below Douglas Dam, Tennessee[3] #	4,543	[1]6,739	[1]3,607	128	–43	...	...	...
04084500	Fox River at Rapide Croche Dam, near Wrightstown, Wisconsin.[2]	6,010	4,238	2,107	98	–8	1,680	1,090	30
04264331	St. Lawrence River at Cornwall, Ontario, near Massena, New York.[4] #	298,800	243,900	254,000	98	–2	253,000	164,000	30
02NG001	St. Maurice River at Grand Mere, Quebec	16,300	24,910	† 9,180	49	–17	...	...	...
05082500	Red River of the North at Grand Forks, North Dakota	30,100	2,593	1,350	110	30	870	562	30
05133500	Rainy River at Manitou Rapids, Minnesota	19,400	12,920	† 6,882	65	15	7,580	4,900	26
05330000	Minnesota River near Jordan, Minnesota	16,200	3,680	* 7,479	787	–21	6,600	4,270	30
05331000	Mississippi River at St. Paul, Minnesota#	36,800	[1]11,020	* 18,960	304	12	19,100	12,300	30
05365500	Chippewa River at Chippewa Falls, Wisconsin	5,650	5,149	5,630	176	68	3,400	2,200	30
05407000	Wisconsin River at Muscoda, Wisconsin	10,400	8,710	5,510	94	1	5,700	3,680	30
05446500	Rock River near Joslin, Illinois	9,549	6,080	2,650	90	–2	2,960	1,910	30
05474500	Mississippi River at Keokuk, Iowa#	119,000	63,790	53,680	124	6	64,200	41,500	30
06214500	Yellowstone River at Billings, Montana	11,795	7,056	3,870	86	9	3,650	2,360	29
06934500	Missouri River at Hermann, Missouri#	524,200	80,880	† 40,900	76	1	38,700	25,000	30
07289000	Mississippi River at Vicksburg, Mississippi[5] #	1,140,500	584,000	243,800	87	–13	245,000	158,000	27
07331000	Washita River near Dickson, Oklahoma	7,202	1,402	* 5,313	1,413	930	2,640	1,700	30
08276500	Rio Grande below Taos Junction Bridge, near Taos, New Mexico.	9,730	742	* 527	207	–11	387	250	30
09315000	Green River at Green River, Utah	44,850	6,391	2,853	103	11	...	...	...
11425500	Sacramento River at Verona, California	21,251	19,430	† 9,463	78	19	...	...	...
13269000	Snake River at Weiser, Idaho	69,200	18,520	† 10,200	77	26	10,800	6,980	30
13317000	Salmon River at White Bird, Idaho	13,550	11,390	† 3,420	74	–16	3,310	2,140	30
13342500	Clearwater River at Spalding, Idaho	9,570	15,510	† 2,140	69	–38	1,850	1,200	30
14105700	Columbia River at The Dalles, Oregon[6] #	237,000	[1]193,500	† [1]83,150	86	–48	123,000	79,600	30
14191000	Willamette River at Salem, Oregon	7,280	[1]23,690	† [1]1,892	47	–36	10,700	6,920	30
15515500	Tanana River at Nenana, Alaska	25,600	23,810	32,200	102	–37	25,300	16,400	30
08MF005	Fraser River at Hope, British Columbia	83,800	96,250	86,860	102	–43	...	...	...

#Indicates stations excluded from the combination bar/line graph. See Explanation of Data.

[1]Adjusted.

[2]Records furnished by Corps of Engineers.

[3]Records furnished by Tennessee Valley Authority.

[4]Records furnished by Buffalo District, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y., when adjusted for storage in Lake St. Lawrence.

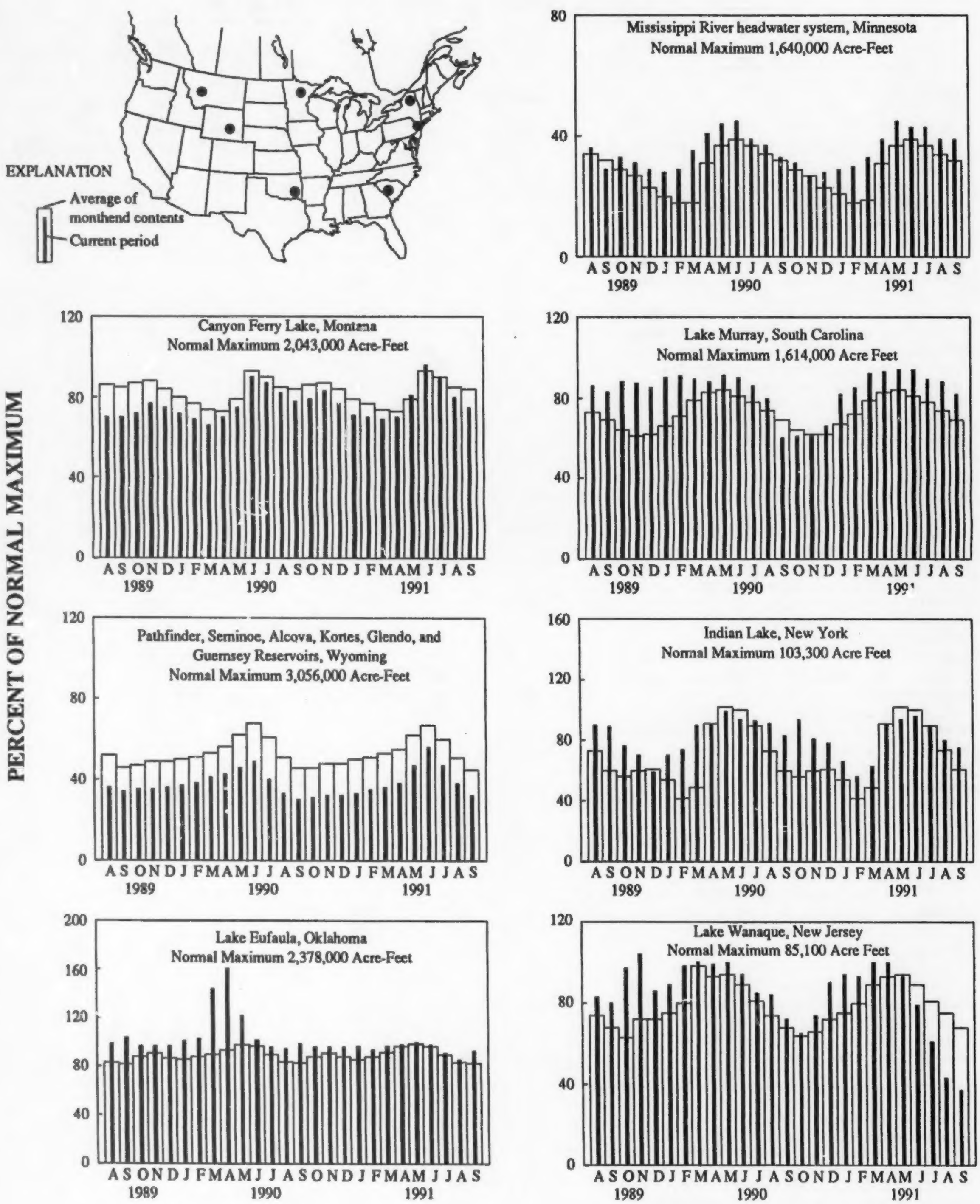
[5]Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.

[6]Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

* Above-normal range

† Below-normal range

USABLE CONTENTS OF SELECTED RESERVOIRS AND RESERVOIR SYSTEMS



Provisional data; subject to revision

USABLE CONTENTS OF SELECTED RESERVOIRS AND RESERVOIR SYSTEMS NEAR END OF SEPTEMBER 1991

[Contents are expressed in percent of reservoir or reservoir system capacity. The usable capacity of reservoir or reservoir system is shown in the column headed "Normal maximum"]

Reservoir or reservoir system Principal uses: F-Flood control I-Irrigation M-Municipal P-Power R-Recreation W-Industrial	Percent of normal maximum End of September 1991	End of September 1990	Average for end of September	End of August 1991	Normal maximum (acre-feet)[1]
NOVA SCOTIA					
Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P)	...	...	...	...	[2]226,300
QUEBEC					
Allard (P)	68	75	69	68	280,600
Gouin (P)	66	68	69	69	6,954,000
MAINE					
Seven Reservoir Systems (MP)	63	66	58	74	4,107,000
NEW HAMPSHIRE					
First Connecticut Lake (P)	*85	71	78	84	76,450
Lake Francis (FPR)	*94	77	77	78	99,310
Lake Winnipesaukee (PR)	*71	75	65	79	165,700
VERMONT					
Harriman (P)	*76	109	65	75	116,200
Somerset (P)	69	75	71	68	57,390
MASSACHUSETTS					
Cobble Mountain and Borden Brook (MP)	73	83	73	82	77,920
NEW YORK					
Great Sacandaga Lake (FPR)	†53	68	63	64	786,700
Indian Lake (FMP)	*75	83	61	80	103,300
New York City Reservoir System (MW)	†52	78	75	64	1,680,000
NEW JERSEY					
Wanaque (M)	†37	72	68	43	85,100
PENNSYLVANIA					
Allegheny (FPR)	†28	49	41	35	1,180,000
Pymatuning (FMR)	†75	99	83	81	188,000
Raystown Lake (FR)	64	67	62	65	761,900
Lake Wallenpaupack (PR)	56	60	56	68	157,800
MARYLAND					
Baltimore Municipal System (M)	†76	92	85	81	261,900
NORTH CAROLINA					
Bridgewater (Lake James) (P)	*91	91	84	95	288,800
Narrows (Badin Lake) (P)	92	90	96	90	128,900
High Rock Lake (P)	*78	65	65	77	234,800
SOUTH CAROLINA					
Lake Murray (P)	*82	60	69	88	1,614,000
Lakes Marion and Moultrie (P)	*87	78	69	84	1,777,000
SOUTH CAROLINA-GEORGIA					
Strom Thurmond Lake (FP)	*75	54	56	77	1,730,000
GEORGIA					
Burton (PR)	*99	98	81	100	104,000
Sinclair (MPR)	86	91	82	87	214,000
Lake Sidney Lanier (FMPR)	*60	48	52	67	1,686,000
ALABAMA					
Lake Martin (P)	*91	86	78	96	1,375,000
TENNESSEE VALLEY					
Clinch Projects: Norris and Melton Hill Lakes (FPR)	*51	49	38	59	2,293,000
Douglas Lake (FPR)	*51	33	33	71	1,395,000
Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR)	*79	65	59	87	1,012,000
Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR)	*56	52	46	65	2,880,000
Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR)	*74	34	56	84	1,478,000
WISCONSIN					
Chippewa and Flambeau (PR)	*80	87	74	78	365,000
Wisconsin River (21 Reservoirs) (PR)	*74	90	64	82	399,000
MINNESOTA					
Mississippi River Headwater System (FMR)	*39	33	32	39	1,640,000
NORTH DAKOTA					
Lake Sakakawea (Garrison) (FIPR)	†66	59	87	87	22,700,000
SOUTH DAKOTA					
Angostura (I)	70	40	67	75	130,770
Belle Fourche (I)	†11	12	31	15	185,200
Lake Francis Case (FIP)	*78	65	72	77	4,589,000
Lake Oahe (FIP)	61	56	66	62	22,240,000
Lake Sharpe (FIP)	105	103	101	101	1,697,000
Lewis and Clark Lake (FIP)	100	99	105	94	432,000
NEBRASKA					
Lake McConaughy (IP)	†43	45	66	43	1,948,000
OKLAHOMA					
Eufaula (FPR)	*93	99	83	86	2,378,000
Keystone (FPR)	†79	82	91	77	661,000
Tenkiller Ferry (FPR)	*100	102	92	98	628,200
Lake Altus (FIMR)	50	57	46	50	133,000
Lake O'The Cherokees (FPR)	*88	90	82	89	1,492,000
OKLAHOMA-TEXAS					
Lake Texoma (FMPRW)	*97	95	91	96	2,722,000
TEXAS					
Bridgeport (IMW)	*90	92	50	89	386,400
Canyon (FMR)	*87	93	79	86	385,600
International Amistad (FIMPW)	*104	90	82	93	3,497,000
International Falcon (FIMPW)	73	45	73	53	2,668,000
Livingston (IMW)	*100	99	88	100	1,788,000
Possum Kingdom (IMPRW)	94	96	95	93	570,200
Red Bluff (P)	20	19	25	16	307,000
Toledo Bend (P)	86	81	82	91	4,472,000
Twin Buttes (FIM)	34	42	34	33	177,800
Lake Kemp (IMW)	*101	95	83	92	268,000
Lake Meredith (FMW)	38	33	39	38	796,900
Lake Travis (FIMPRW)	*85	90	76	85	1,144,000
MONTANA					
Canyon Ferry (FIMPR)	†75	78	84	80	2,043,000
Fort Peck (FPR)	†65	59	86	65	18,910,000
Hungry Horse (FIPR)	86	90	88	97	3,451,000
WASHINGTON					
Ross (PR)	93	90	91	99	1,052,000
Franklin D. Roosevelt Lake (IP)	†95	97	101	96	5,022,000
Lake Chelan (PR)	*91	90	85	97	676,100
Lake Cushman (PR)	90	32	88	103	359,500
Lake Merwin (P)	*103	50	93	102	245,600
IDAHO					
Boise River (4 Reservoirs) (FIP)	†14	29	46	22	1,235,000
Coeur d'Alene Lake (P)	*77	76	65	98	238,500
Pend Oreille Lake (FP)	86	85	90	92	1,561,000
IDAHO-WYOMING					
Upper Snake River (8 Reservoirs) (MP)	†39	24	47	49	4,401,000
WYOMING					
Boysen (FIP)	88	73	83	92	802,000
Buffalo Bill (IP)	†65	39	77	80	421,300
Keyhole (F)	†15	16	42	17	193,800
Pathfinder, Seminoe, Alcova, Kortes, Glendo, and Guernsey Reservoirs (I)	†32	30	45	38	3,056,000
COLORADO					
John Martin (FIR)	†2	5	16	2	364,400
Taylor Park (IR)	*80	76	62	84	106,200
Colorado-Big Thompson Project (I)	56	49	59	60	730,300
COLORADO RIVER STORAGE PROJECT					
Lake Powell; Flaming Gorge, Fontenelle, Navajo, and Blue Mesa Reservoirs (IFPR)	†65	68	82	66	31,620,000
UTAH-IDAHO					
Bear Lake (IPR)	†31	35	61	32	1,421,000
CALIFORNIA					
Folsom (FIP)	†51	17	57	53	1,000,000
Hetch Hetchy (MP)	*68	40	60	77	360,400
Isabella (FIR)	†17	8	30	18	568,100
Pine Flat (FI)	†3	2	36	3	1,001,000
Clair Engle Lake (Lewiston) (P)	†29	48	72	37	2,438,000
Lake Almanor (P)	*68	74	56	74	1,036,000
Lake Berryessa (FIMW)	†36	39	75	38	1,600,000
Millerton Lake (FI)	35	36	36	41	503,200
Shasta Lake (FIPR)	†30	37	64	30	4,377,000
CALIFORNIA-NEVADA					
Lake Tahoe (IPR)	†0	0	53	0	744,600
NEVADA					
Rye Patch (I)	†1	1	51	4	194,300
ARIZONA-NEVADA					
Lake Mead and Lake Mohave (FIMP)	74	77	74	74	27,970,000
ARIZONA					
San Carlos (IP)	*36	4	19	35	935,100
Salt and Verde River System (IMPR)	*77	39	41	79	2,019,100
NEW MEXICO					
Conchas (FIR)	87	59	85	71	315,700
Elephant Butte and Caballo (FIPR)	*71	58	36	71	2,394,000

[1] 1 acre-foot = 0.04356 million cubic feet = 0.326 million gallons = 0.504 cubic feet per second per day.

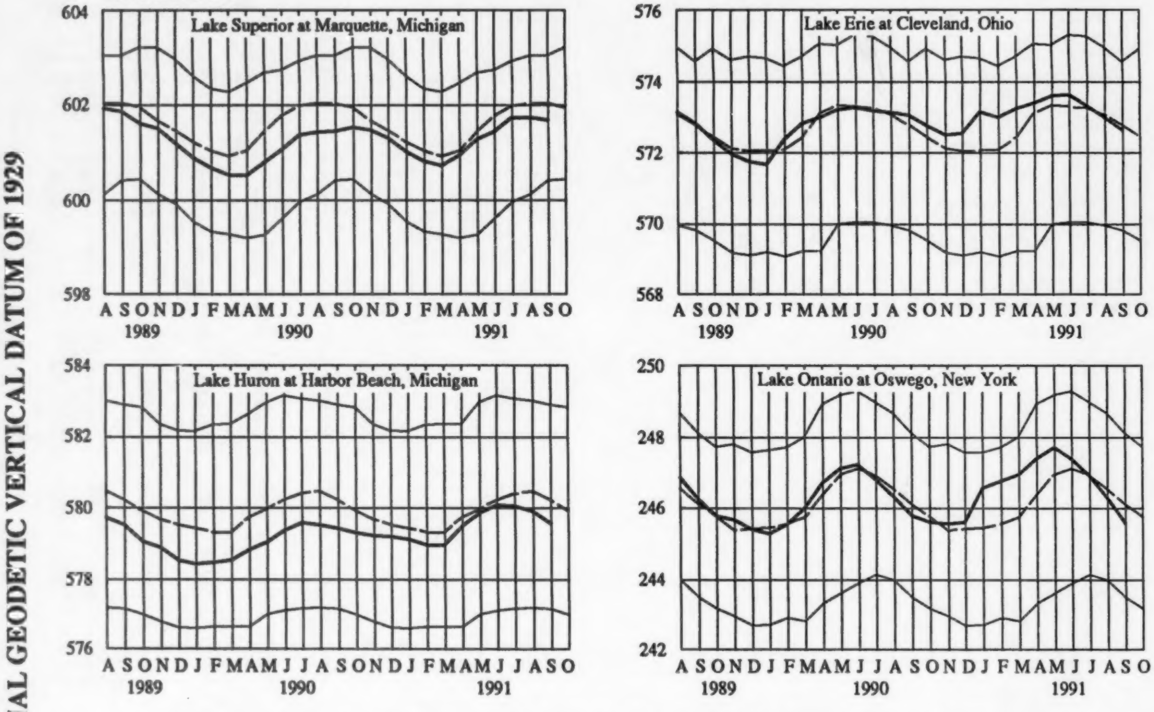
[2] Thousands of kilowatt-hours (the potential electric power that could be generated by the volume of water in storage).

* Above-average range

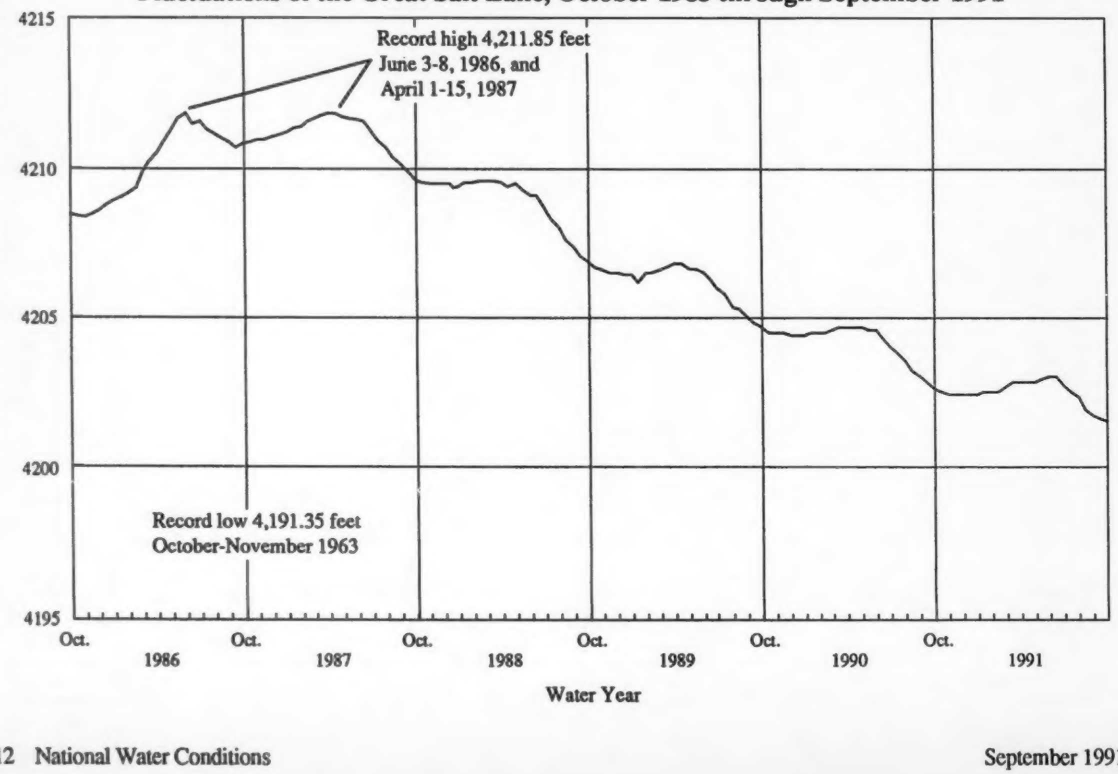
† Below-average range

GREAT LAKES ELEVATIONS

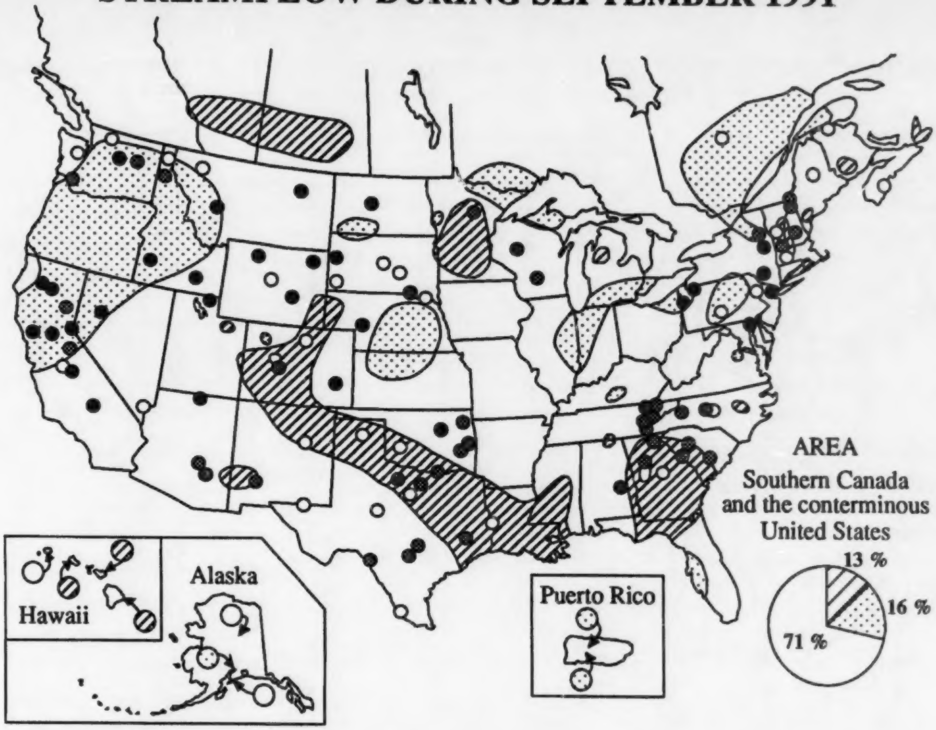
Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951-80. Heavy line indicates mean for current period. Data from National Ocean Service.



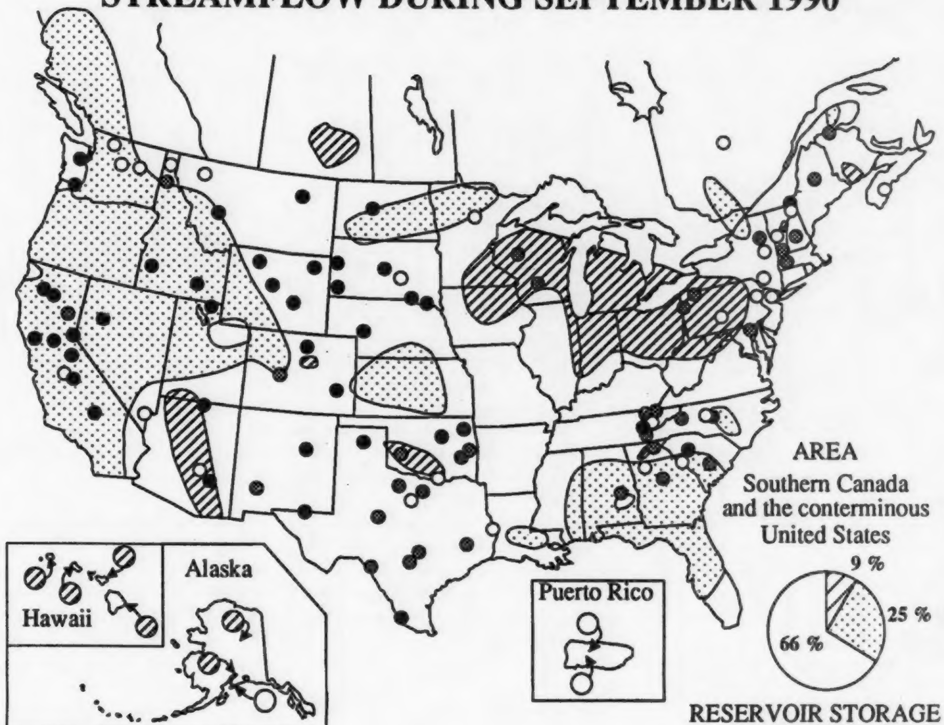
Fluctuations of the Great Salt Lake, October 1985 through September 1991



STREAMFLOW DURING SEPTEMBER 1991



STREAMFLOW DURING SEPTEMBER 1990

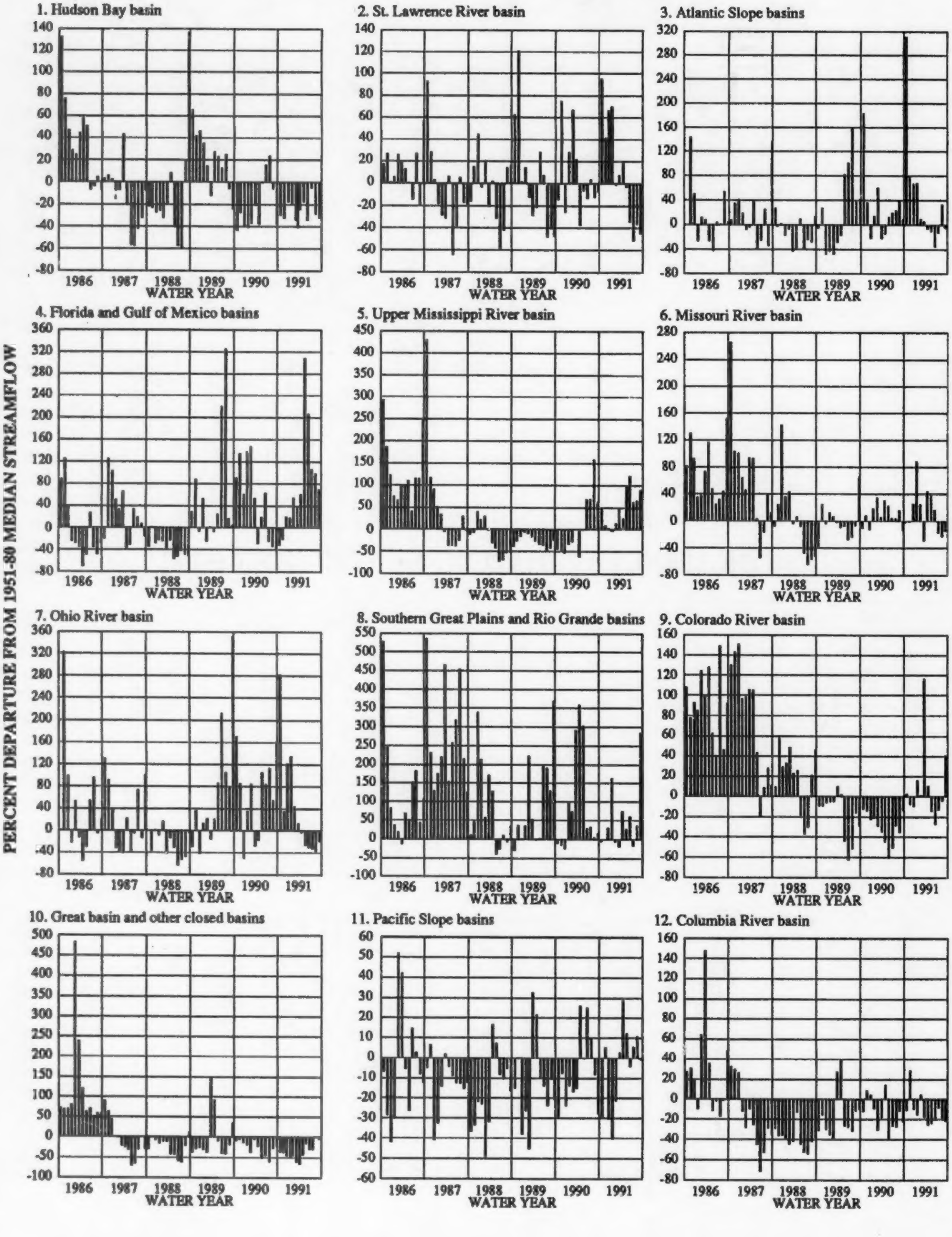


Above-normal range

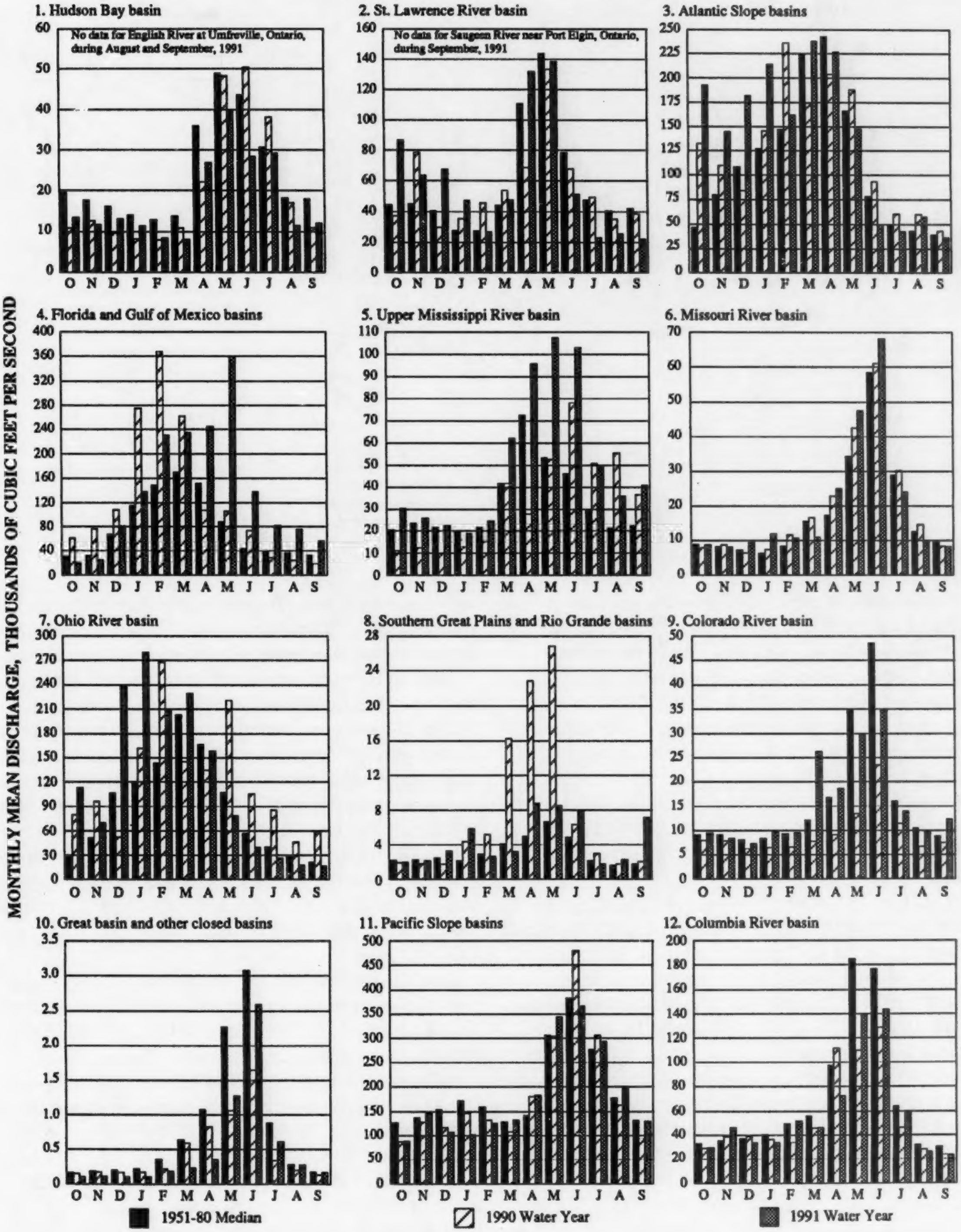
Below-normal range

RESERVOIR STORAGE
- Above average range
- Average range
- Below average range

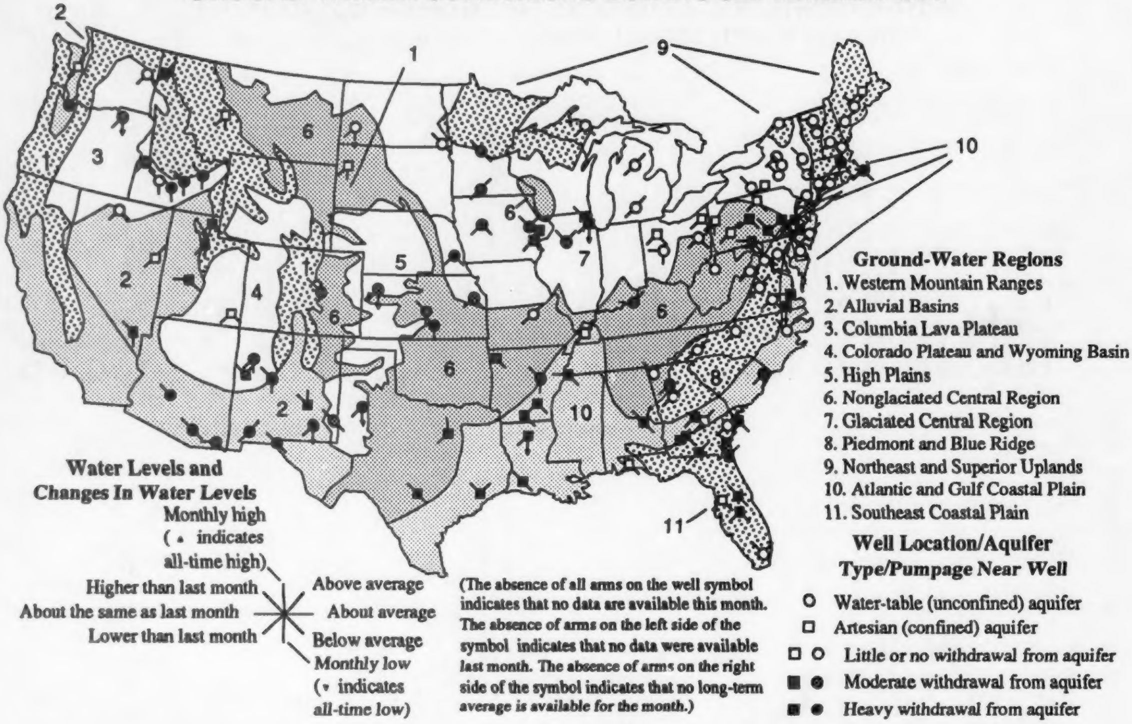
MONTHLY DEPARTURE OF ACTUAL STREAMFLOW (OCTOBER 1985-SEPTEMBER 1991) FROM MEDIAN STREAMFLOW (1951-80)



ACTUAL MONTHLY STREAMFLOW, 1990 AND 1991 WATER YEARS, COMPARED WITH MEDIAN MONTHLY STREAMFLOW, 1951-80



GROUND-WATER CONDITIONS DURING SEPTEMBER 1991



New extremes occurred at 31 ground-water index stations (table on page 18) during September—27 lows (including 10 all-time) and 4 highs—compared with 26 new extremes last month. Graphs showing ground-water levels at seven stations for the past 26 months, including one of those at which a September low occurred (in the Columbia Lava Plateau region in Idaho), are on page 19. The other graphs on page 19 are for wells in the Alluvial Basins region in Arizona, the Glaciated Central region in Kansas and Michigan, the Southeast Coastal Plain region in Georgia, the Piedmont and Blue Ridge region in Virginia, and the Northeast and Superior Uplands region in Maine.

Water levels in the Western Mountain Ranges region were below last month's levels and mixed with respect to long-term averages. Level fell to a September low in the well in Montana.

In the Alluvial Basins region, ground-water levels were generally below last month's levels in Washington and Utah, above last month's levels in Arizona and Texas, and mixed with respect to last month's levels in Nevada and New Mexico. Levels were above long-term average in Oregon, below long-term averages in Washington, Utah, Arizona, and Texas, and mixed with respect to average in Nevada and New Mexico. Level fell to an all-time low in the Roswell Basin shallow aquifer well at Dayton, New Mexico. September lows occurred in wells in Nevada, Utah, and New Mexico. A September high occurred in one well in New Mexico.

In the Columbia Lava Plateau region, ground-water levels were above last month's levels in most of Idaho and below last month's level in Oregon. Levels were below long-term averages throughout the Region. September lows occurred in wells in Idaho and Oregon. Level fell to an all-time low in a well in the Columbia River basalt aquifer at Pendleton, Oregon.

Ground-water levels in the Colorado Plateau and Wyoming Basin region were below last month's level in Utah and mixed with respect to last month's levels in New Mexico. Levels were mixed with respect to long-term averages. A September low occurred in one well in New Mexico.

In the High Plains region, ground-water levels were mixed with respect to last month's levels and below long-term averages throughout the region. Levels fell to all-time lows in wells in the Ogallala aquifer near Colby, Kansas and near Lubbock, Texas.

Ground-water levels in the Nonglaciated Central region were above last month's levels in Colorado, Kansas, West Virginia, and Georgia; below last month's levels in the Dakotas, Missouri, and Virginia; and mixed in Texas and Pennsylvania. Levels were generally below long-term averages in the Dakotas, Kansas, Pennsylvania, Maryland, and Virginia; above average in Missouri, Kentucky, West Virginia, and Georgia; and mixed with respect to average in Texas. September lows occurred in the Dakotas and Kansas. Monthly highs occurred in one well in Texas and the well in West Virginia. Level fell to an all-time low in a well in the Sentinel Butte aquifer near Dickinson, North Dakota.

Provisional data; subject to revision

WATER LEVELS IN KEY OBSERVATION WELLS IN SOME REPRESENTATIVE AQUIFERS IN THE CONTERMINOUS UNITED STATES–SEPTEMBER 1991

GROUND–WATER REGION Aquifer and Location	Aquifer type and local aquifer pumpage	Depth of well in feet	Water level in feet below land–surface datum	Departure from average in feet	Net change in water level in feet since:		Year records began	Remarks
					Last month	Last year		
WESTERN MOUNTAIN RANGES (1)								
Rathdrum Prairie aquifer near Athol, northern Idaho	●	485	457.4	1.5	–0.1	3.1	1929	
ALLUVIAL BASINS (2)								
Alluvial valley fill aquifer in Steptoe Valley, Nevada	□	122	9.38	3.33	–.46	–.26	1949	
Alluvial sand and gravel aquifer, Baldwin Park, California	●	200	...	...	...	...	1932	
Valley fill aquifer, Elfrida area near Douglas, Arizona	●	124	103.30	–18.55	.02	–2.01	1947	
Hueco bolson aquifer at El Paso, Texas	●	640	272.69	–18.85	.31	.12	1964	
COLUMBIA LAVA PLATEAU (3)								
Snake River Plain aquifer near Eden, Idaho	●	208	123.0	–7.7	.6	–5.2	1962	Sept. low
Columbia River basalt aquifer, Pendleton, Oregon		1,501	223.93	–34.5	–1.00	–2.56	1965	All–time low
COLORADO PLATEAU AND WYOMING BASIN (4)								
Dakota aquifer near Blanding, Utah	□	140	49.16	–4.03	–.37	–3.08	1960	
HIGH PLAINS (5)								
Ogallala aquifer near Colby, Kansas	●	175	131.33	–11.08	–.26	–1.10	1947	All–time low
Southern High Plains aquifer, Lovington, New Mexico	●	212	59.94	–5.23	.17	.13	1971	
NONGLACIATED CENTRAL REGION (6)								
Sentinel Butte aquifer near Dickinson, North Dakota	○	160	21.63	–3.28	–.12	–.74	1968	All–time low
Sand and gravel Pleistocene aquifer near Valley Center, Kansas	●	54	20.82	–3.49	.32	–1.09	1937	Sept. low
Glacial outwash sand and gravel aquifer near Louisville, Kentucky	●	94	17.02	7.33	–.06	.71	1945	
Upper Pennsylvanian aquifer in the Central Appalachians Plateau near Glenville, West Virginia	○	25	13.17	4.07	.19	.22	1953	Sept. high
GLACIATED CENTRAL REGION (7)								
Fluvial sand and gravel aquifer, Platte River Valley, near Ashland, Nebraska	●	12	8.25	–1.84	–1.35	–1.52	1933	
Sheyenne Delta aquifer near Wyndmere, North Dakota	○	40	7.93	–1.73	.21	.82	1963	
Pleistocene (glacial drift) aquifer at Princeton in northern Illinois	●	29	8.35	4.26	.23	–1.73	1942	
Shallow drift aquifer near Roscommon in north–central part of Lower Peninsula, Michigan	○	14	4.85	.20	–.25	.46	1934	
Silurian–Devonian carbonate aquifer near Dola, Ohio	□	51	11.31	–2.35	–1.70	–2.35	1954	
PIEDMONT AND BLUE RIDGE (8)								
Water–table aquifer in Petersburg Granite, southeastern Piedmont, Colonial Heights, Virginia	○	100	17.26	–1.13	–.41	–2.25	1939	
Weathered granite aquifer, western Piedmont, Mocksville area, North Carolina	○	31	16.36	3.97	–.57	1.28	1981	
Surficial aquifer at Griffin, Georgia	○	30	16.82	.32	–1.60	3.00	1943	
NORTHEAST AND SUPERIOR UPLANDS (9)								
Pleistocene glacial outwash aquifer, at Camp Ripley, near Little Falls, Minnesota	●	59	13.84	–.7	.18	1.02	1949	
Glacial till aquifer at Augusta, Maine	○	22	6.63	2.52	.98	1.50	1960	
Shallow sand aquifer (glacial deposits), Acton, Massachusetts	●	34	20.05	–.22	–.18	–.14	1965	
Pleistocene sand aquifer near Morrisville, Vermont	○	50	20.26	–.42	.04	–.91	1966	
ATLANTIC AND GULF COASTAL PLAIN (10)								
Columbia deposits aquifer near Camden, Delaware	○	11	8.08	–.80	–.68	–.99	1950	
Memphis sand aquifer near Memphis, Tennessee	■	384	107.71	–16.02	–.05	.18	1940	
Eutaw aquifer in the City of Montgomery, Alabama	■	270	24.8	–.3	.6	2.9	1952	
Evangeline aquifer at Houston, Texas	■	1,152	299.39	5.95	1.35	12.37	1978	
SOUTHEAST COASTAL PLAIN (11)								
Upper Floridan aquifer on Cockspur Island, Savannah area, Georgia	■	348	33.90	–5.15	.36	5.88	1956	
Upper Floridan aquifer, Jacksonville, Florida	■	905	–23.8	28.0	.4	5.2	1930	
Biscayne aquifer near Homestead, Florida	○	20	5.49	.43	–1.10	.54	1932	

Ground-water levels in the Glaciated Central region were above last month's level in North Dakota, mixed with respect to last month's levels in Iowa, Illinois, and New York, and at or below last month's levels elsewhere. Levels were above long-term average in Minnesota and Michigan, mixed with respect to average in Iowa and Illinois, and below average elsewhere. All-time lows occurred in wells in the Cambrian-Ordovician aquifer at Mt. Vernon, Iowa, and in the Lower Mount Simon aquifer at Illinois Beach State Park, Illinois.

Ground-water levels were below last month's throughout the Piedmont and Blue Ridge region. Levels were below long-term average in Maryland; above long-term averages in North Carolina; and mixed elsewhere in the region. A September high occurred in a well in North Carolina.

Provisional data; subject to revision

NEW EXTREMES DURING SEPTEMBER AT GROUND–WATER INDEX STATIONS

WRD Station Identification Number	GROUND–WATER REGION Aquifer and Location	Aquifer type and local aquifer pumpage	Depth of well	End–of–month water level in feet below land surface datum: Previous September Record: Years of record	Average	Extreme (year)	September 1991
	LOW WATER LEVELS						
	WESTERN MOUNTAIN RANGES						
463906112043901	Cretaceous aquifer near Helena, Montana	□	110	14	28.78	34.19 (1985)	36.25
	ALLUVIAL BASINS						
324340104231701	Roswell Basin shallow aquifer at Dayton, New Mexico	●	250	39	92.93	122.59 (1990)	[1]123.11
351051106395304	Basin-fill aquifer at Albuquerque, New Mexico	●	980	8	34.50	37.43 (1990)	37.71
361611115151301	Valley fill aquifer near Las Vegas, Nevada	■	905	45	36.45	100.74 (1990)	104.43
403803111505301	Basin fill aquifer near Holladay, Utah	■	165	12	72.85	88.31 (1990)	91.33
	COLUMBIA LAVA PLATEAU						
423659114111601	Snake River Plain aquifer near Eden, Idaho	●	208	28	115.3	122.6 (1982)	123.0
424053113412801	Snake River Plain aquifer near Rupert, Idaho	●	194	40	151.6	161.2 (1990)	163.4
425635114382301	Snake River Plain aquifer at Gooding, Idaho	○	165	18	130.1	139.4 (1961)	140.7
432700112470801	Snake River Plain aquifer near Atomic City, Idaho	●	636	40	584.8	587.5 (1979)	588.1
453934118491701	Columbia River basalts aquifer at Pendleton, Oregon	●	1,501	26	189.43	221.36 (1990)	[1]223.93
	COLORADO PLATEAU AND WYOMING BASIN						
352023107473201	Westwater Canyon aquifer near Grants-Bluewater, New Mexico	●	155	1	70.70	70.70 (1981)	79.05
	HIGH PLAINS						
341010102240801	Ogallala aquifer near Lubbock, Texas	●	202	39	56.39	89.55 (1990)	[1]92.45
392329101040201	Ogallala aquifer near Colby, Kansas	●	175	44	120.25	130.23 (1990)	[1]131.33
	NONGLACIATED CENTRAL REGION						
375039097234201	Sand and gravel Pleistocene aquifer near Valley Center, Kansas	●	54	54	17.33	20.13 (1956)	20.82
375810097324301	Equus aquifer near Halstead, Kansas	●	57	50	23.58	36.81 (1990)	39.60
441759103261201	Minnelusa aquifer near Tilford, South Dakota	□	302	6	20.54	38.84 (1989)	44.49
465755102410701	Sentinel Butte aquifer near Dickinson, North Dakota	○	160	22	18.35	20.89 (1990)	[1]21.63
	GLACIATED CENTRAL REGION						
395118082573300	Glacial drift aquifer near Reese, Ohio	○	53	45	12.38	13.29 (1988)	13.47
410538080280801	Sandstone and shale aquifer at Pulaski State Game Land 150 near Pulaski, Pennsylvania	□	150	23	17.37	18.74 (1985)	18.76
415534091251502	Cambrian-Ordovician aquifer at Mt. Vernon, Iowa	■	1,557	4	336.39	338.13 (1990)	[1]341.21
422803087475302	Lower Mount Simon aquifer at Illinois Beach State Park, Illinois	■	2,264	2	201.64	202.68 (1990)	[1]205.15
422803087475304	Ironton-Galesville aquifer at Illinois Beach State Park, Illinois	■	1,203	2	233.40	233.41 (1990)	233.75
	ATLANTIC AND GULF COASTAL PLAIN						
322357092341701	Sparta aquifer near Ruston, Louisiana	■	703	17	222.69	234.80 (1986)	[1]237.35
335115079033500	Pee Dee aquifer at Collins Park at Conway, South Carolina	■	438	17	34.82	62.24 (1990)	63.40
344607091543401	Mississippi Valley alluvial aquifer near Lonoke, Arkansas	●	135	15	110.56	120.03 (1190)	120.84
364059076544901	Middle Potomac aquifer at Franklin, Virginia	■	305	30	167.72	207.98 (1990)	[1]211.08
372506076511703	Upper Potomac aquifer near Toano, Virginia	■	401	6	158.03	161.94 (1990)	[1]163.47
	HIGH WATER LEVELS						
	ALLUVIAL BASINS						
332615104303601	Roswell Basin artesian aquifer at Roswell, New Mexico	■	324	24	62.24	48.40 (1990)	41.00
	NONGLACIATED CENTRAL REGION						
324842097102901	Twin Mountains (Trinity) aquifer near Hurst/Fort Worth, Texas	■	667	13	464.44	452.59 (1983)	446.80
385604080495901	Upper Pennsylvanian aquifer near Glenville, West Virginia	○	25	37	17.24	13.39 (1990)	13.17
	PIEDMONT AND BLUE RIDGE						
355359080331701	Weathered granite aquifer near Mocksville, North Carolina	○	31	9	20.33	17.52 (1984)	16.36

[1] All–time month–end low.

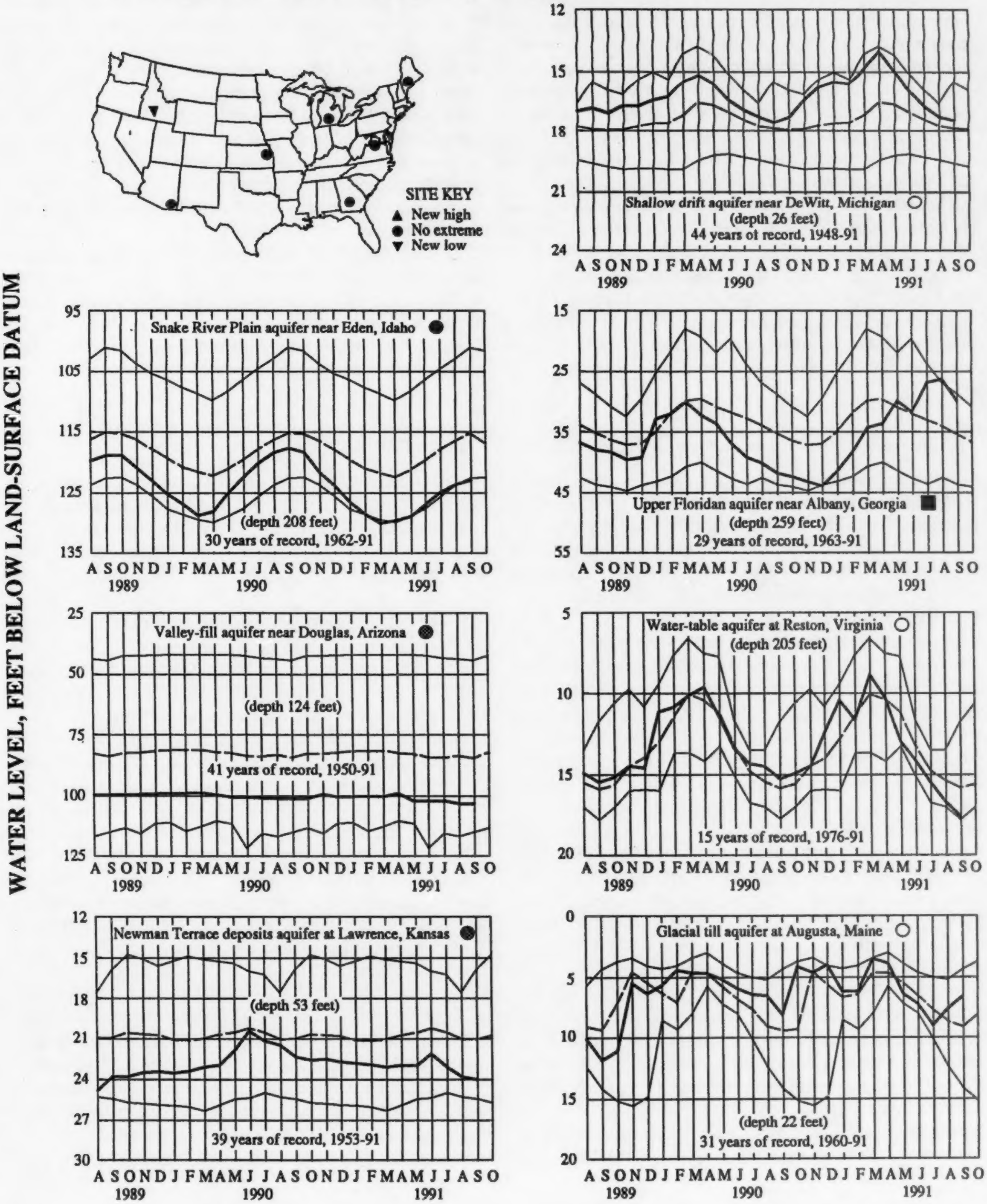
In the Northeast and Superior Uplands region, ground-water levels were at or above last month's in Minnesota and Vermont, mixed in Maine and New Hampshire, and below last month's levels elsewhere in the region. Water levels were below average in Minnesota, Michigan, and Massachusetts; mixed in New Hampshire and Vermont; and at or above long-term average elsewhere.

In the Atlantic and Gulf Coastal Plain region, ground-water levels were above last month's in North Carolina, Alabama, and Texas; mixed in Arkansas and Louisiana; and below last month's levels elsewhere. Water levels were above long-term averages in North Carolina, Kentucky, and Texas; mixed with respect to average in New Jersey and Georgia; and below average elsewhere. September lows occurred at wells in Virginia, South Carolina, Arkansas, and Louisiana. All-time lows occurred at wells in the Middle Potomac aquifer at Frankin and Upper Potomac aquifer near Toano, Virginia, and in the Sparta aquifer near Ruston, Louisiana.

In the Southeast Coastal Plain region, ground-water levels were mixed with respect to last month's levels and also with respect to long-term averages throughout the region.

MONTHEND GROUND-WATER LEVELS IN SELECTED WELLS

Area between light-weight solid lines indicates range between highest and lowest record for the month. Dashed line indicates average of monthly levels in previous years. Heavy line indicates level for current period.



Early Freeze Hits the Midwest

The calendar still said summer, but that did not halt the temperature's nose-dive in Valentine, NE. At dawn on Thursday, September 19, the thermometer registered 17 °F, demolishing the daily record of 27 °F, set in 1896. Farther east, on the western fringe of the primary Corn and Soybean Belt, temperatures sagged into the mid 20's in eastern South Dakota and northeastern Nebraska. Subfreezing minimums were recorded as far east as southwestern Minnesota, central Iowa, and northwestern Missouri. Nearly 4 dozen daily record lows were broken throughout the Plains and the western Corn Belt.

On the 20th, parts of southern Minnesota and northeastern Iowa experienced minimums in the upper 20's. An additional 25 record lows were set from the Corn Belt to Texas. The cold outbreak, although unusually harsh for the third week of September, was short lived. The Canadian-origin, sun-warmed airmass reached the East by the 22nd, setting a few more record lows and inducing scattered frost in the eastern Corn Belt and the Northeast before losing its chill.

The freeze damaged some immature crops in the western Corn Belt. Early reports indicate that damage was mostly confined to Iowa and Minnesota, and mainly to soybeans rather than corn. In Iowa, where the overall condition of the soybean crop deteriorated slightly last week, the impact was greatest in the north-central part of the State. In Minnesota, where soybean conditions also deteriorated slightly, the impact was reportedly greatest in the south-central region. In Nebraska, though temperatures were lower, crops escaped serious damage because they were mature. Temperatures remained above freezing in Texas, but wet, cold weather on the plains dealt cotton "a serious setback," according to the State crop report.

This early freeze is similar in some ways to the freeze that struck the Midwest in September 1974, though the impact is much less severe this year because more of the crop is mature. On September 21-23, 1974, temperatures dropped into the 20's across the Dakotas, Iowa, and Wisconsin. Even Toledo, OH, reported a reading of 26 °F on the 23rd.

SEPTEMBER WEATHER SUMMARY

September's weather was typically transitional, as late-summer hot spells were interspersed with Canadian high pressure system intrusions. The month's most notable cold snap (September 19-21, over 100 daily record lows set) immediately followed summer's last heat wave (September 12-17, about 130 daily record highs notched), and cut the growing season short in parts of the western Corn and Soybean Belt.

The West enjoyed September's finest weather, especially toward month's end. Temperature anomalies generally exceeded +4 °F from central Washington to south-central California. Portland, OR, not only had its warmest September ever, but also received a mere 0.02 inches of rain (3rd driest September). In contrast, cool, wet weather plagued the southern Plains, with temperature departures reaching -4 °F from western Texas to southern Oklahoma. Elsewhere, temperatures were slightly below normal from the Great Lakes to New England, near normal in the Southeast, and somewhat above normal in the northern Plains.

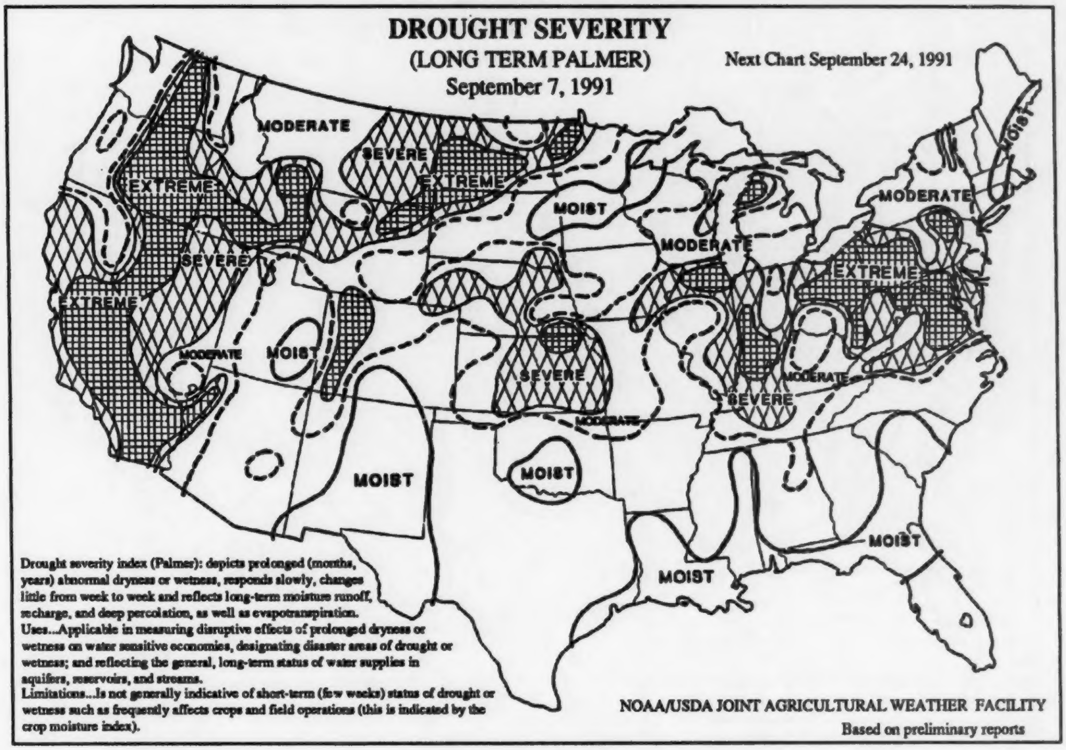
Rainfall patterns were highly variable, but a few trends were clear. Two to four times the normal rainfall drenched southern Plains cotton areas. Oklahoma City, OK, on the northeastern cotton cropland fringe, received a September-record 11.85 inches of rain (348 percent of normal). Unusually dry weather prevailed in the central Plains and the Southeast. Savannah, GA, garnered only 0.35 inches of rain to set a September record for dryness. Rainfall for the Corn Belt as a whole was below normal for the 4th consecutive month. A few locations in the mid-Atlantic region reported a 6th drier-than-normal month in a row, for example, Scranton, PA, and Baltimore, MD. Several rainfall records for dryness were tied or broken in the Pacific Northwest. Olympia and Seattle, WA, which both normally receive greater than 2 inches of September rainfall, recorded record-tying traces of rain.

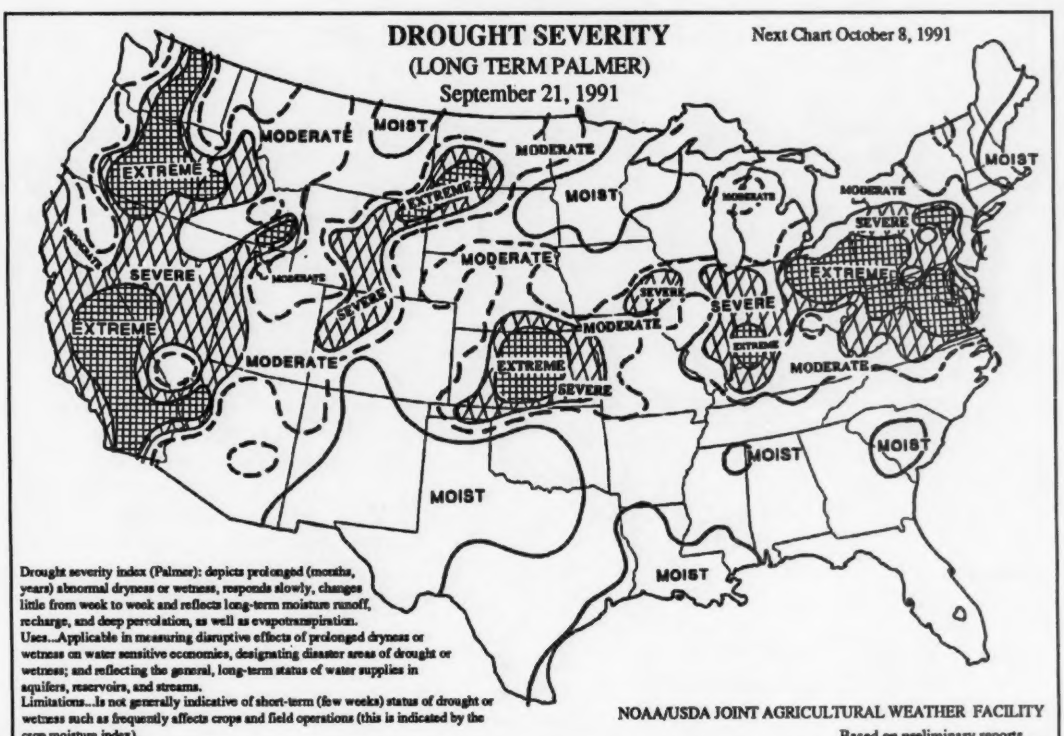
Locally heavy rain was common in the southern Plains until the 20th. The rainfall event of the 18th and 19th seemed to be especially damaging to cotton, because several inches of rain fell while temperatures plummeted into the 40's. Rain was common in the upper Mississippi Valley until the 17th, with the month's most significant rainfall occurring on the 7th and 8th. Additional heavy rain fell on the 13th and 14th. In the West, frequent afternoon thunderstorms rumbled during the first half of September. A 24-hour rainfall record was established in Utah on the 7th as over 8 inches of rain deluged North Ogden. The month's final episode of significant rain affected the East on the 24th and 25th. The last few days of September were nearly dry nationwide.

Snow is still an infrequent word during September, but a couple of non-mountain locations managed to set snowfall records. Duluth, MN, set a September monthly record due to a 2.4-inch snowfall on the 17th and 18th. Caribou, ME, recorded its first ever measurable September snow on the 29th and 30th (2.5 inches).

Record heat appeared in the South on the 12th and made a quick trek toward the north and east. Greer, SC, set seven consecutive daily record highs. The late heat wave helped to smash records in New York, NY, and Philadelphia, PA, for the total number days on which the temperature reached 90 °F during a year. On the 16th, New York's Central Park temperature reached the 90 °F mark for the 38th time. The old record was set in 1944. Philadelphia attained a 90 °F reading for the 52nd time, toppling the record set in 1988. But summer ended suddenly east of the Rockies. On the 19th and 20th, temperatures sagged below freezing from Nebraska and Iowa northward, damaging immature soybeans in the western Corn Belt. Cool weather continued in the East until month's end. Buffalo, NY, tied a September record with a 32 °F reading on the 30th. Meanwhile, the West basked in unusual warmth. The mercury reached a daily record of 102 °F in Sacramento, CA, on the final day of the month.

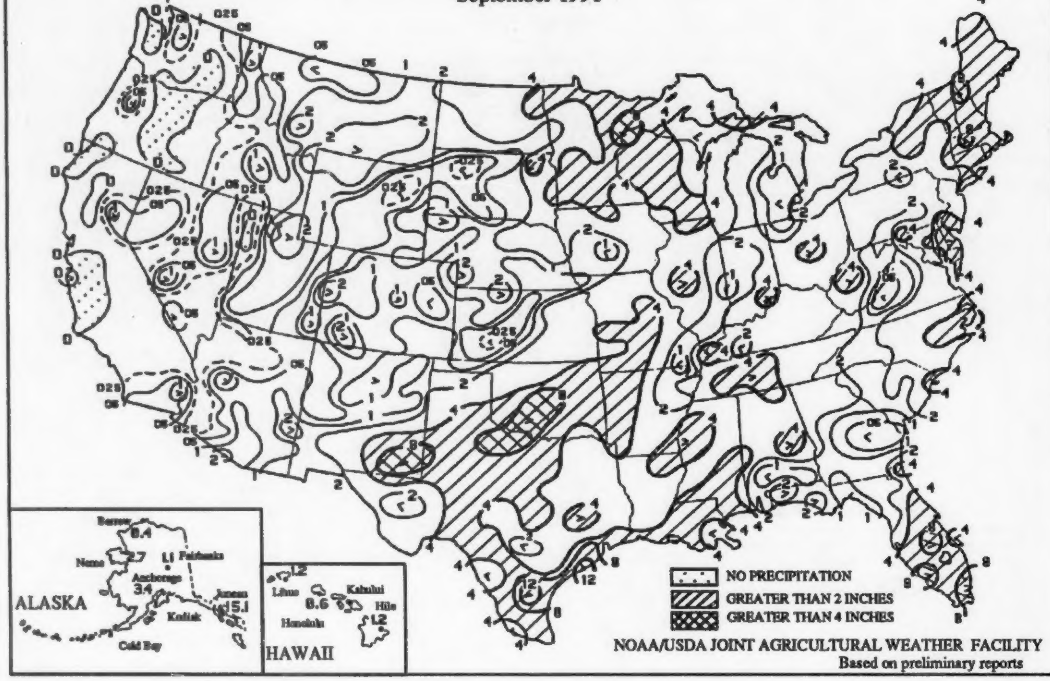
(From *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Weather Facility)



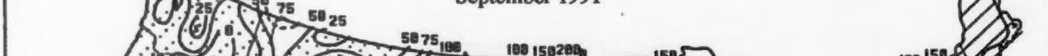


(From *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Weather Facility)

TOTAL PRECIPITATION, INCHES
September 1991



PERCENTAGE OF NORMAL PRECIPITATION
September 1991

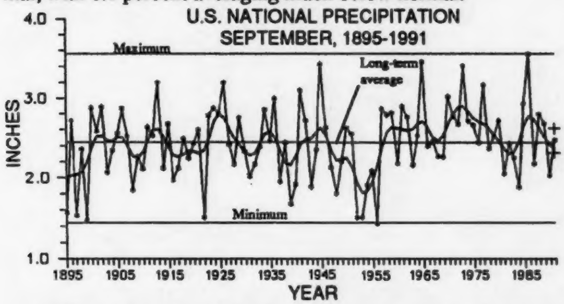


(From *Weekly Weather and Crop Bulletin* prepared and published by the NOAA/USDA Joint Agricultural Weather Facility)

UNITED STATES SEPTEMBER CLIMATE IN HISTORICAL PERSPECTIVE

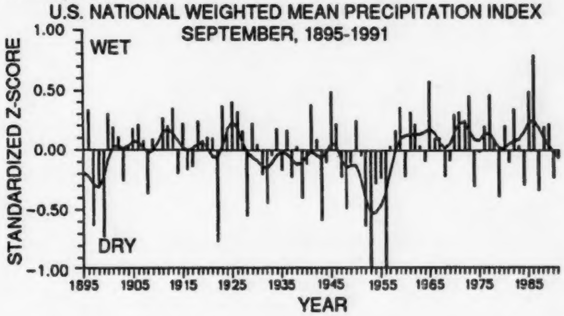
Preliminary data for September 1991 indicate that temperature averaged across the contiguous United States was near the long-term mean. September 1991 ranked as the 52nd coldest (46th warmest) September on record (the record begins in 1895).

Although the month averaged near normal, there was considerable variability in temperature on both a temporal and spatial basis. According to the National Weather Service, a heat wave at mid-month brought reports of record-breaking daily high temperatures from about 130 stations. The heat wave was followed by an outbreak of very cold air which brought just over 100 reports of record daily low temperatures. Spatially, about seven percent of the country had monthly average temperatures much above normal, with 6.1 percent averaging much below normal.

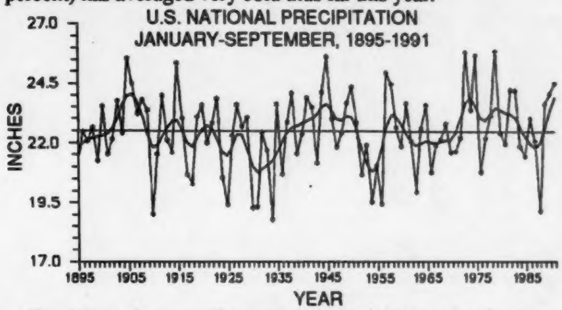


Areally-averaged precipitation for the nation was nearly normal for September (graph above), ranking September 1991 as the 47th wettest (51st driest) September on record. The preliminary value for precipitation is estimated to be accurate to within 0.15 inches and the confidence interval is plotted as a '+'. About one-tenth of the country experienced much wetter than normal conditions and just over fifteen percent was much drier than normal.

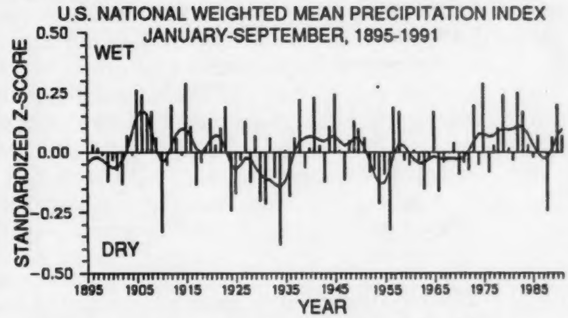
Historical precipitation is shown in a different way in the graph below. Precipitation for each climate division in the contiguous U.S. was first standardized using the gamma distribution over the 1951-80 period. These gamma-standardized values were then weighted by area and averaged to determine a national standardized precipitation value. Negative values are dry, positive are wetter than the mean. This index gives a more accurate indication of how precipitation across the country compares to the local normal climate. The areally-weighted mean standardized national precipitation ranked September 1991 as the 38th driest (60th wettest) on record.



The year so far, for the nation as a whole, has been unusually warm, with January-September 1991 ranking as the seventh warmest January-September period on record. About a third (33.1 percent) of the country has averaged very warm when compared to the normal while less than one percent of the country (0.6 percent) has averaged very cold thus far this year.



For the nation, areally-averaged precipitation for January-September 1991 ranked as eighth wettest, comparable in the aggregate to the wet spell of the early 1970's. (See graph above.) When the local normal climate is taken into account, however, 1991 ranked as the 29th wettest January-September period on record (graph below), being above normal as a whole but not significantly so.

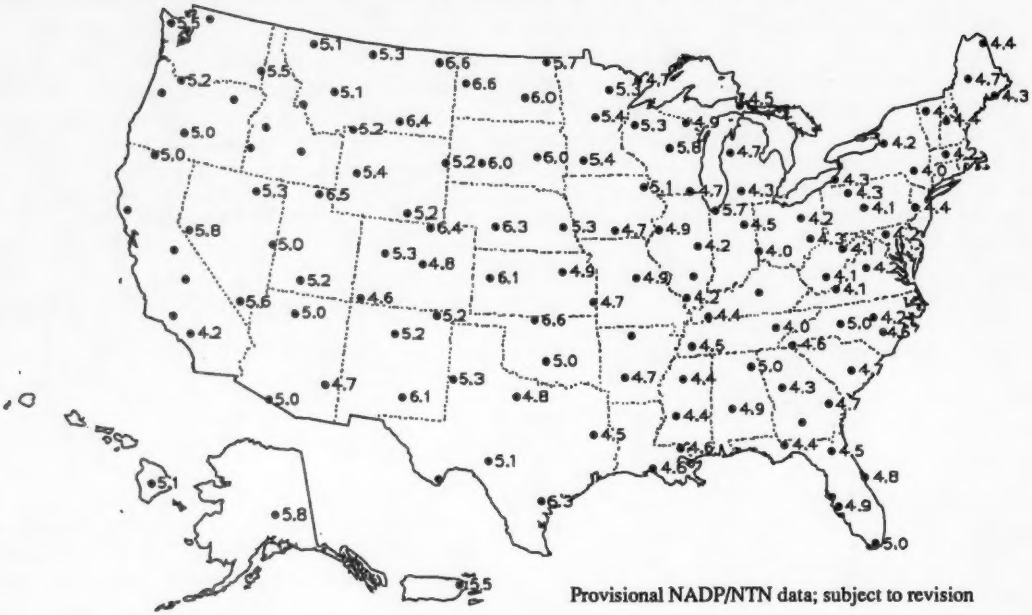


Long-term drought conditions on a national scale decreased slightly during September. The percent area of the contiguous U.S. experiencing long-term drought (as defined by the Palmer Drought Index) decreased to about 15 percent. At the same time, the percent area experiencing long-term wet conditions also dropped somewhat but continued to hover around the 9 to 10 percent range.

Only 4.7 percent of the nation suffered from below normal precipitation for the January through September period while 12.8 percent experienced much above normal rainfall. For the nine-month period January through September, four states (Indiana, Maryland, Ohio, and Pennsylvania) have had their tenth driest or drier year, while five other states have had their fifteenth driest or drier year. On the other extreme, seven states have had their tenth wettest or wetter January through September period on record including Florida and Louisiana, with their wettest January through September period on record.

(From *Climate Variations Bulletin*, National Climatic Data Center, NOAA)

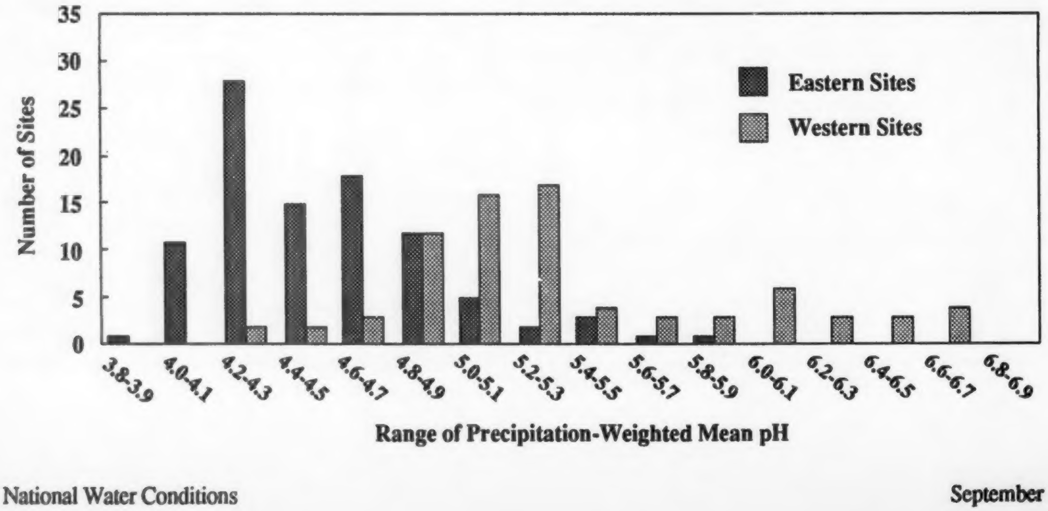
pH of Precipitation for August 26-September 22, 1991



Current pH data shown on the map (• 4.9) are precipitation-weighted means calculated from preliminary laboratory results provided by the NADP/NTN Central Analytical Laboratory at the Illinois State Water Survey and are subject to change. The 128 points (•) shown on this map represent a subset of all sites chosen to provide relatively even geographic spacing. Absence of a pH value at a site indicates either that there was no precipitation or that data for the site did not meet preliminary screening criteria for this provisional report.

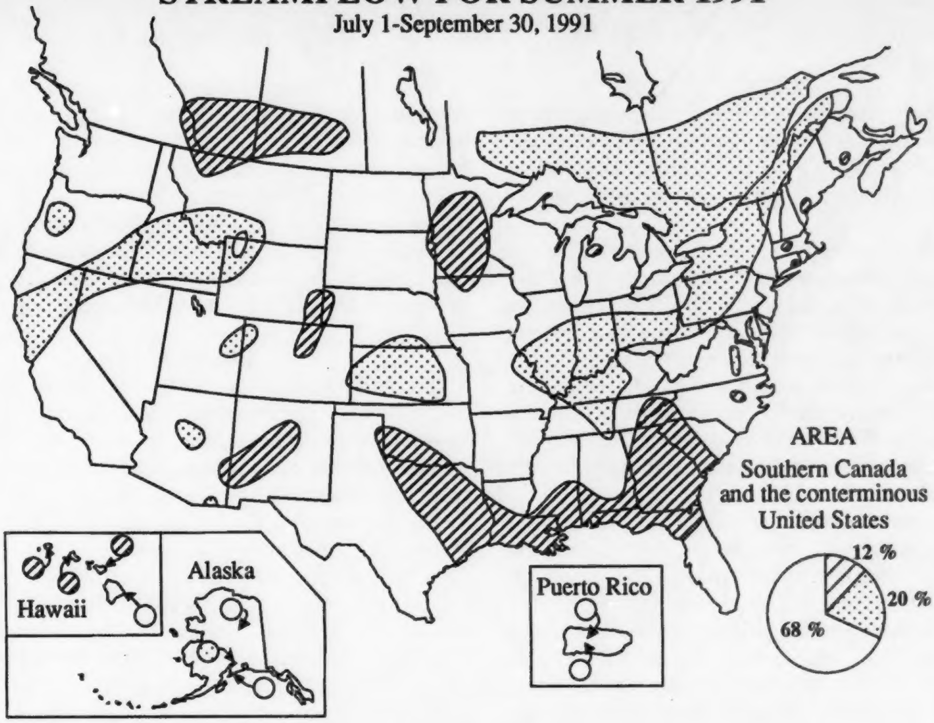
A list of the approximately 200 sites comprising the total Network and additional data for the sites are available from the NADP/NTN Coordination Office, Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, CO 80523.

Distribution of precipitation-weighted mean pH for all NADP/NTN sites having one or more weekly samples for August 26-September 22, 1991. The East/West dividing line is at the western borders of Minnesota, Iowa, Missouri, Arkansas, and Louisiana.



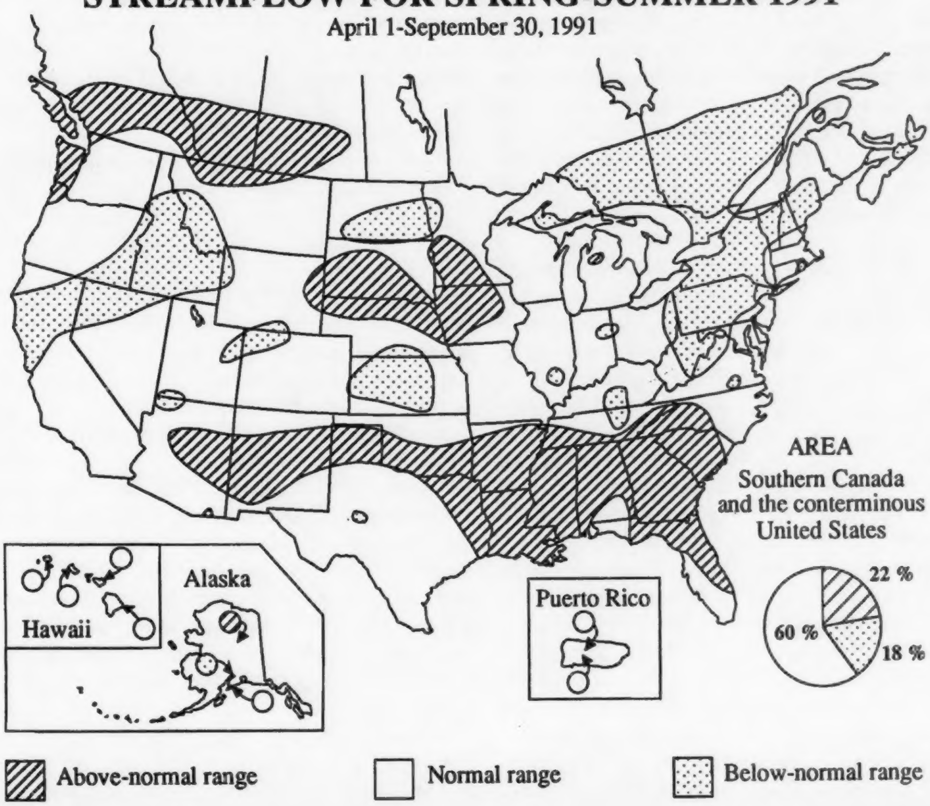
STREAMFLOW FOR SUMMER 1991

July 1-September 30, 1991



STREAMFLOW FOR SPRING-SUMMER 1991

April 1-September 30, 1991



1991 WATER YEAR (OCTOBER 1, 1990-SEPTEMBER 30, 1991) SUMMARY

FLOODS

Tropical storm Klaus caused severe floods, deaths, and damages in parts of **South Carolina and Georgia** during **mid-October**. Peak discharges at 10 streamflow stations exceeded those for both the 100-year recurrence interval flood and previous peaks of record.

The "Pineapple Express"— the name given by the National Weather Service (NWS) to the fall storm route from Hawaii to the Pacific Northwest—brought two storms, with heavy rains and warm temperatures, across **Washington**. Severe floods and damages were caused by the **November 9** and **24** storms.

On **November 20**, a severe flood, which destroyed the gage, occurred on Kamananui Stream at Maunawai, Oahu, **Hawaii**. A week of steady rainfall ended with a sudden thunderstorm, which dropped over 9 inches of rain in 2 hours in the vicinity of Waimea in northern Oahu.

Heavy rains during the **last week of December, combined with melting snow in northern areas caused floods in an area stretching from Alabama to Pennsylvania. The most severe floods occurred in Alabama**, (where peak discharges equalled or exceeded those for the 100-year flood at five stations in the vicinity of Huntsville), **Tennessee** (where peaks of record or the 100-year flood were exceeded at four stations in the south-central part of the State), and **Ohio** (peak discharges at several stations exceeded those of record or the 100-year flood). Peaks in **Indiana** exceeded that of record at one station and equalled the 50-year flood at another.

Heavy rains in **Hawaii March 19-23** caused severe floods, mudslides, a power outage which lasted for several hours on the island of Oahu, and damages which were probably in the millions of dollars. Three storms, which dropped precipitation varying from about 9 inches along the Waianae Leeward Coast and normally dry side of the island to about 34 inches at Waiahole close to the mountains near the north end of Kaneohe Bay. Peak discharges exceeded those of record at two stations on Oahu.

Severe flooding occurred in **southern** and **southeastern Arkansas** after rains of 6-11 inches on **April 28-29**. One person was killed and 100 people were evacuated from their homes owing to flooding. Damage to roads, bridges, and culverts was estimated at more than $3.5 million in Ashley and Union Counties.

Two persons drowned when flash flooding occurred in **Shreveport, Louisiana**, after 7 inches of rain fell on **April 12**. Heavy rains throughout the northern part of the State caused severe flooding near the end of the month, especially along the Ouachita River through Morehouse Parish. About 500 homes were flooded and damages were estimated at about $5 million.

On **May 19**, a full reservoir combined with heavy rains in the **Pendleton, Oregon**, area forced evacuation of families living in low lying areas along McKay Creek and Grande Ronde River.

In **Iowa** floods were caused by locally intense thunderstorms during which more than 6 inches of rain fell in some places on **June 14-15**. Extensive flooding occurred in the East Nishnabotna River basin in the southwestern part of the State, with Interstate Highway 80 near Wiota (about 60 miles west of Des Moines) closed for a few hours on June 14, as water flowed over the road. In northeastern Iowa, flood stages exceeding those of record occurred at three stations in the Turkey River basin on June 14-15. Flooding on the Turkey River and its tributaries destroyed several bridges and flooded several towns. Clayton County was declared a disaster area by the Governor.

On **August 11-12**, a glacial-outburst flood occurred at **Alaska's Strandline Lake**, about 70 miles west of Anchorage. Strandline Lake is dammed by the Triumvirate Glacier, which originates in the Tordrillo Mountains that include Mt. Spurr.

DROUGHT

After several months of deficient rainfall in **northern Florida** (Jacksonville to Pensacola), new minimums of record occurred at many hydrologic data-collection sites during **late September and early October**. New minimum discharges occurred at 8 of 40 streamflow stations, with recurrence intervals at some sites exceeding 50 years. New lows occurred in 16 of 29 wells in the Floridan aquifer, ranging from less than 0.1 foot to about 2.6 feet below previous lows of record. Levels at 5 of 7 lakes in the area set record lows, ranging from about 0.6 foot to 4.2 feet lower than previous records. Rains during mid-October alleviated drought conditions in the area somewhat. Total rainfall at Jacksonville Airport for the water year (provisional NWS data) was 21.95 inches below normal as of September 30 and total rainfall for the calendar year was 21.95 inches below normal as of October 5.

In **California**, October precipitation at 207 reporting stations averaged 69 percent below the historic average for the month. Average storage in 155 reservoirs was at 34 percent of capacity at the end of October, which is only 60 percent of the historical average for the end of October. Storage was also 24 percent lower than at the end of October 1989.

According to the ***California Water Supply Outlook***, "Statewide runoff as of January 1 was 20 percent of average, slightly below 1977 levels. Statewide snowpack is also 20 percent of average as of January 23, with an average snow water content of about 3 inches.

In-state reservoir storage in 155 major reservoirs was about 54 percent of the historical average on January 1. Normally these reservoirs would be gaining during January. For the first 3 weeks, it appears that storage has actually declined slightly. Continuation of the trend to the end of January would result in February 1 statewide reservoir storage about 50 percent of average.

According to the ***Weekly Weather and Crop Bulletin***, "Heavy rain developed on **February 27** from San Francisco southward and continued in southern California until March 1. Storm rainfall totals were generally 3 to 5 inches in coastal areas but approached 15 inches in the mountains northeast of San Diego. Rain and mountain snow reached northern California by the 28th, continuing until March 4. Liquid equivalent precipitation exceeded 4 inches along the west slopes of the southern Cascades and the Sierra Nevada range from Mount Shasta southward to Sequoia National Park.

"But the drought is not over. Through the end of February, this water year is still the third driest on record, after 1977 and 1924. A comparison to 1977 shows similar percentages of normal

precipitation through the end of February. Only about 30 percent of the annual total precipitation can be expected for the next 7 months. The Metropolitan Water District, which serves 15 million customers in southern California, has already reduced water supplies by 50 percent to agricultural users and by 20 percent to residential customers. In the State's fertile, but irrigation dependent, Central Valley, a 75- to 100-percent reduction in water deliveries is a precaution in case the drought lasts into a sixth year.

"In just 5 days, statewide percentage of normal precipitation for the water year vaulted from 21 to 41 percent. In the Sierra Nevada Mountains, snowpack increased from 14 percent of normal to 42 percent of normal. At the end of February, the State's reservoir holdings stood at 48 percent of normal. The State's runoff, as measured by river gauging stations, was an anemic 15 percent of normal. Reservoir levels and runoff improved during the first few days of March."

In the **Great Basin,** total **April** streamflow at the four streamflow index stations was about 66 percent below median, compared with 63 percent below median during March, despite an increase of 51 percent from March to April. Total flow has increased over that for the previous month since January 1991, but has been below median since April 1990. Flows have been in the below-normal range at all four stations for many months. The contents of Rye Patch reservoir rose to about 8 percent of capacity at the end of April after being at about 7 percent of capacity at the end of March. Contents had been slightly under 1 percent of capacity at the end of both November and December 1990. Water level in the alluvial aquifer index well near Las Vegas fell 4.40 feet from the end of March to the end of April, but was 8.12 feet above the all-time low which occurred in July 1990.

Eight July lows occurred at streamflow index stations in Maine, Quebec, Ontario, and Nova Scotia, as dry conditions spread into the Northeast.

DURING THE WATER YEAR

Lake Tahoe (California-Nevada) had no usable storage for the entire year.

Utah's Great Salt Lake peaked at 4,202.90 feet above National Geodetic Vertical Datum of 1929 on May 15. The seasonal low of 4,202.40 feet above NGVD of 1929 occurred November 1-December 31.

FOR THE WATER YEAR

For the 1991 water year, the combined flow of the 3 largest rivers in the lower 48 States—Mississippi, St. Lawrence, and Columbia—averaged 1,188,000 cfs (17 percent above median and in the above-normal range): about 2 percent more than for water year 1990, for which the average flow was in the normal range. Annual mean flow of the St. Lawrence River was 4 percent above median and in the normal range for the second consecutive year. Mean flow of the Mississippi River was 28 percent above median and in the above-normal range for the second consecutive year. Flow of the Columbia River was 4 percent above median and in the normal range after being in the below-normal range for 1990.

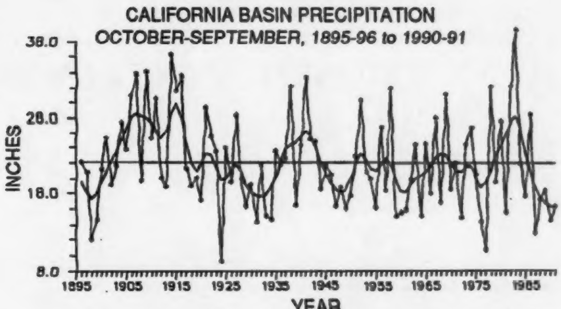
Streamflow was in the normal to above-normal range at 83 percent of the index stations in the United States, Puerto Rico, and southern Canada for water year 1991 compared with 76 percent in those ranges for water year 1990. The area of the conterminous United States and southern Canada with normal to above-normal flow for the 1991 water year was 84 percent compared with 76 percent for the 1990 water year. Maps on the following three pages show streamflow conditions for the water year, locations of index stations where new monthly extremes occurred, and streamflow conditions maps for seasons of the year.

Graphs showing the monthly (October 1944-September 1991) and annual (water years 1921-91) distribution of area in the conterminous United States and southern Canada are on page 30. Monthly and annual statistics based on these data are given below.

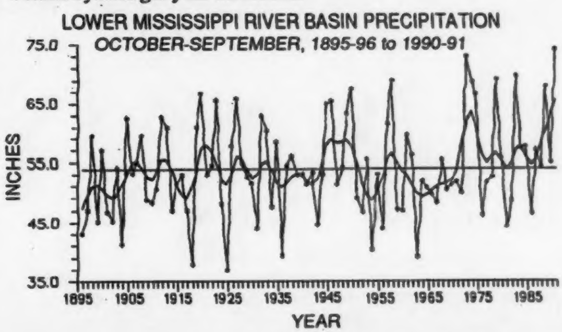
	BELOW NORMAL		NORMAL		ABOVE NORMAL	
MONTHLY	Percent	Month and year	Percent	Month and year	Percent	Month and year
Maximum	61.8	June 1988	94.4	August 1945	55.1	April 1969
Minimum	0	August and September 1945	35.9	June 1988	2.2	June 1988
Average	16.4	......	63.1	......	20.4	......

	BELOW NORMAL		NORMAL		ABOVE NORMAL	
ANNUAL	Percent	Water year	Percent	Water year	Percent	Water year
Maximum	66.5	1931	79.0	1923	51.6	1973
Minimum	2.1	1975	27.6	1934	1.7	1940
Average	17.7	......	62.1	......	20.2	......

PRECIPITATION

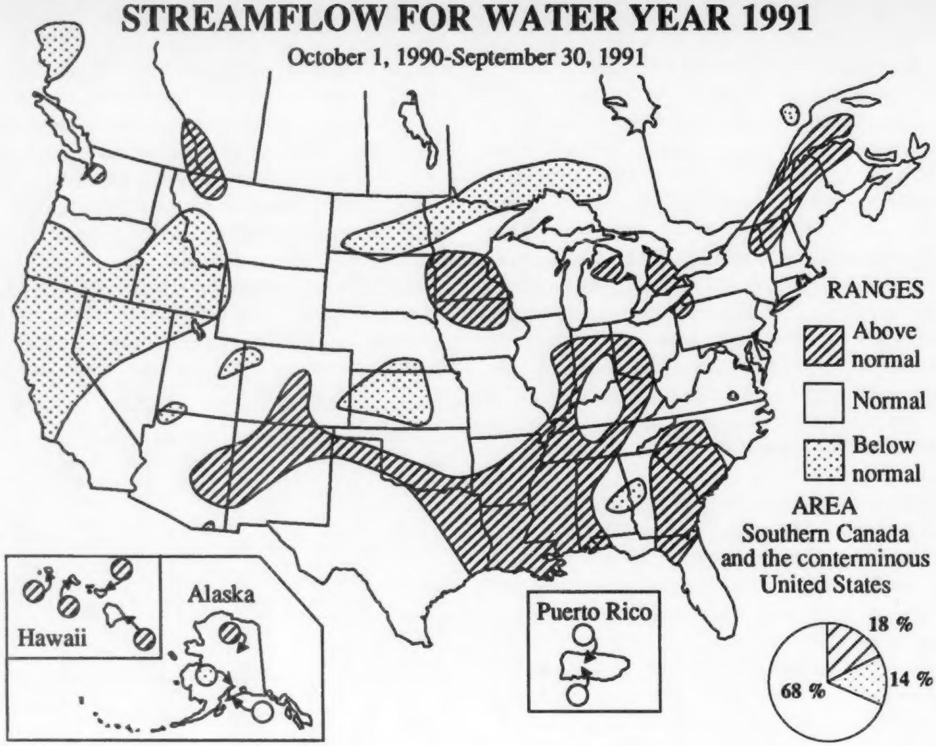


According to the National Climatic Data Center, "10 river basins had a hydrologic year (October-September) precipitation total in the top third wettest of the distribution; three of these ranked in the top 10 wettest of all time. The driest was the California River Basin which logged their 21st driest hydrologic year (graph above). This continued to place the filtered curve at record low levels. On the other hand, the Lower Mississippi (graph below) and the South Atlantic-Gulf Basins each had their wettest hydrologic year on record."

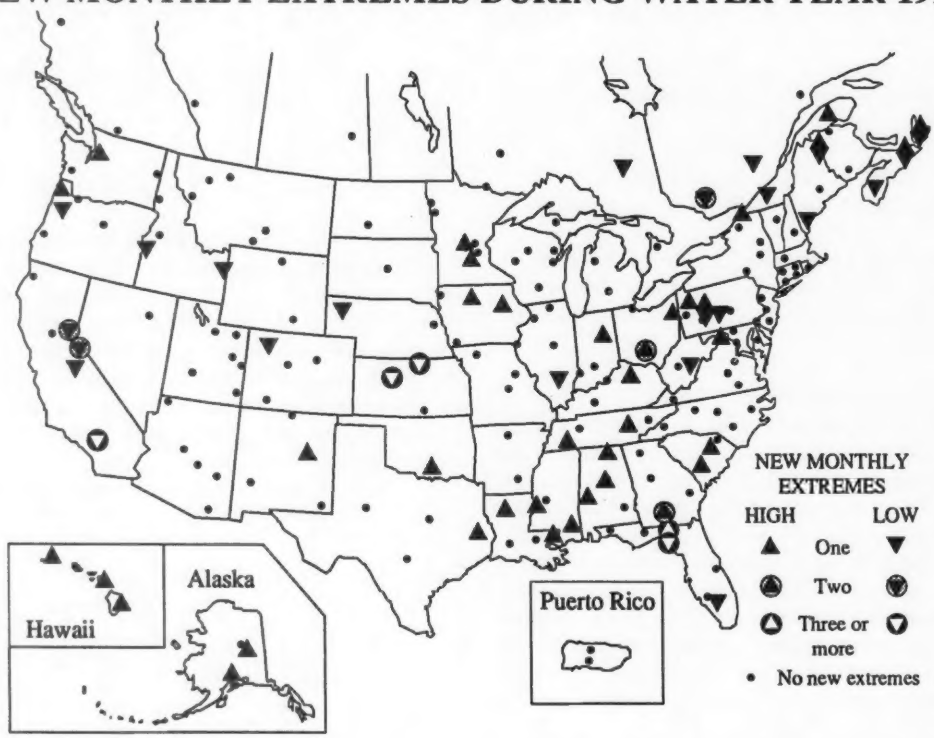


STREAMFLOW FOR WATER YEAR 1991

October 1, 1990-September 30, 1991

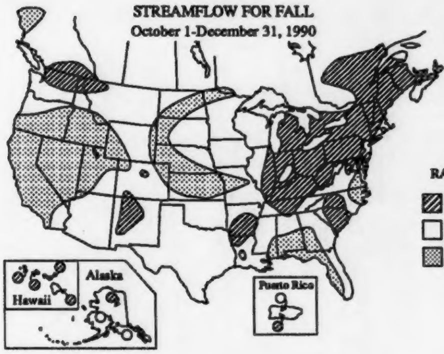


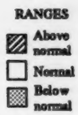
NEW MONTHLY EXTREMES DURING WATER YEAR 1991



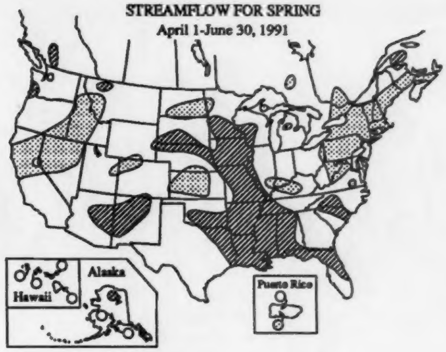
STREAMFLOW MAPS FOR THE 1991 WATER YEAR

STREAMFLOW FOR FALL
October 1-December 31, 1990

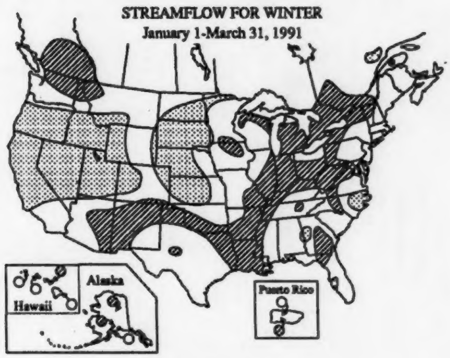




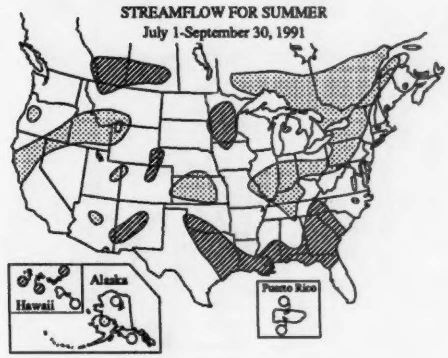
STREAMFLOW FOR SPRING
April 1-June 30, 1991



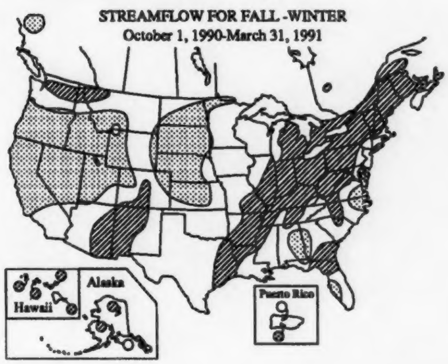
STREAMFLOW FOR WINTER
January 1-March 31, 1991



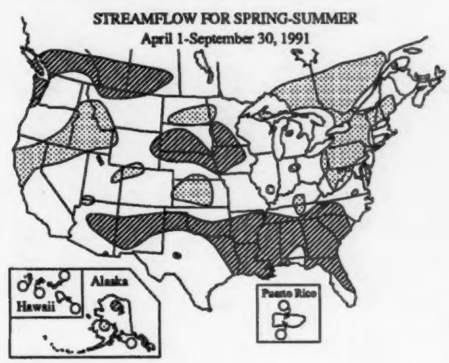
STREAMFLOW FOR SUMMER
July 1-September 30, 1991



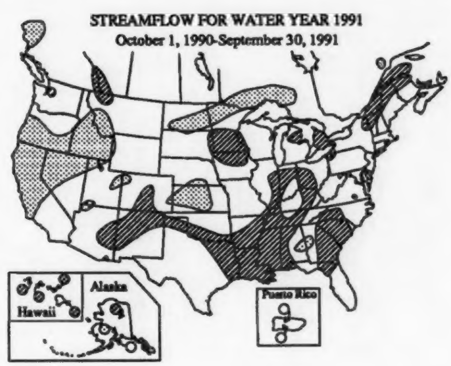
STREAMFLOW FOR FALL -WINTER
October 1, 1990-March 31, 1991



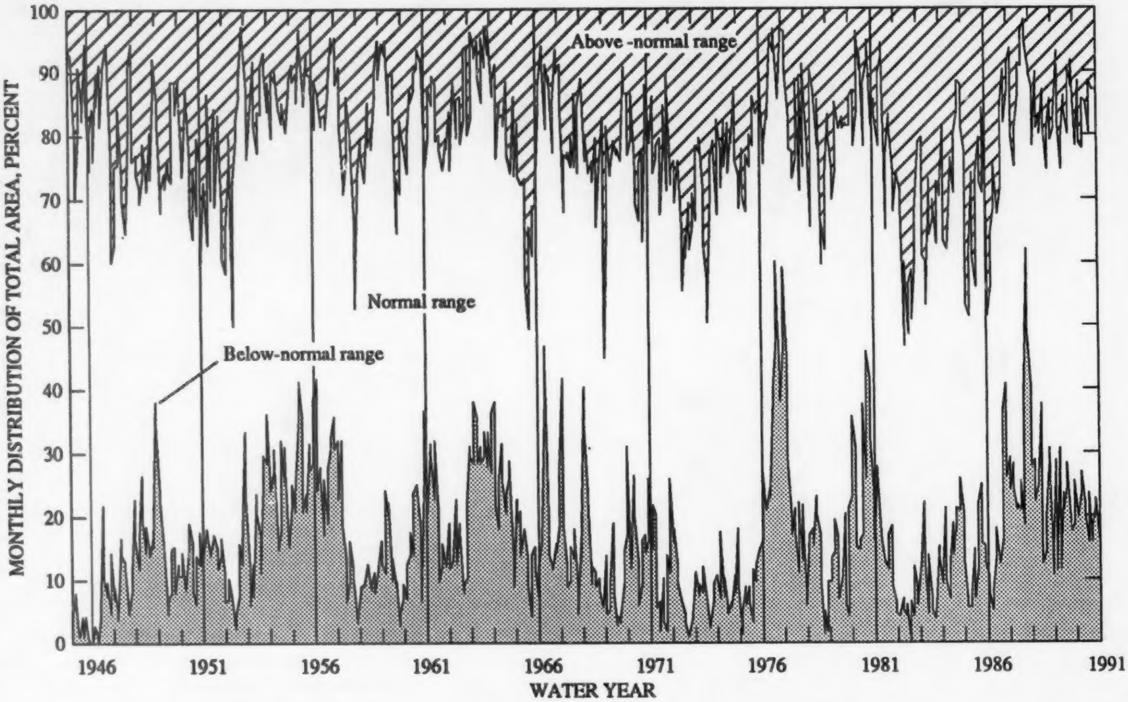
STREAMFLOW FOR SPRING-SUMMER
April 1-September 30, 1991

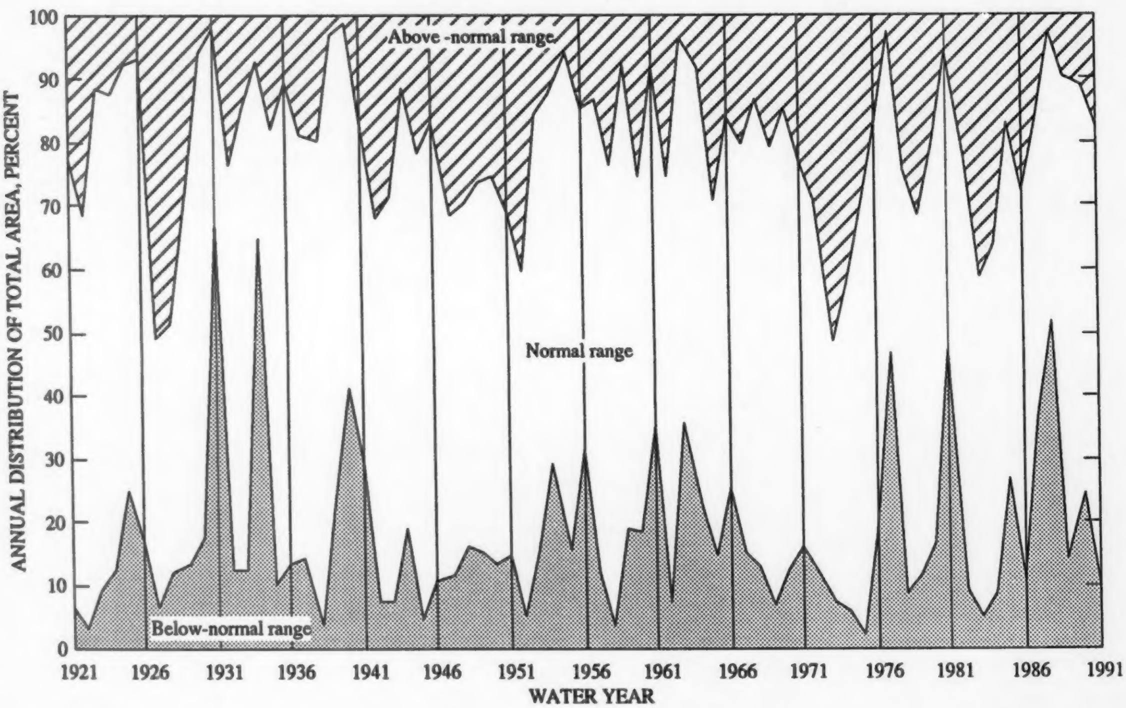


STREAMFLOW FOR WATER YEAR 1991
October 1, 1990-September 30, 1991

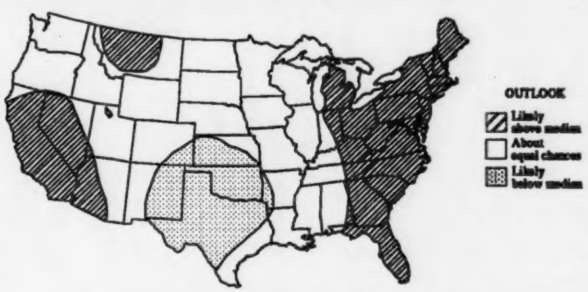


DISTRIBUTION OF AREA IN THE CONTERMINOUS UNITED STATES AND SOUTHERN CANADA STREAMFLOW RANGES BASED ON 1951-80 REFERENCE PERIOD





TEMPERATURE OUTLOOK FOR OCTOBER-DECEMBER 1991



PRECIPITATION OUTLOOK FOR OCTOBER-DECEMBER 1991

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EXPLANATION OF DATA (Revised December 1990)

Cover map shows generalized pattern of streamflow for the month based on provisional data from 186 index gaging stations—18 in Canada, 166 in the United States, and 2 in the Commonwealth of Puerto Rico. Alaska, Hawaii, and Puerto Rico inset maps show streamflow only at the index gaging stations that are located near the point shown by the arrows. Classifications on map are based on comparison of streamflow for the current month at each index station with the flow for the same month in the 30-year reference period, 1951-80. Shorter reference periods are used for one Canadian index station, two Kansas index stations, and the Puerto Rico index stations because of the limited records available.

The ***streamflow ranges map*** shows where streamflow has persisted in the above- or below-normal range from last month to this month and also where streamflow is in the above- or below-normal range this month after being in a different range last month. Three ***pie charts*** show: the percent of stations reporting discharges in each flow range for both the conterminous United States and southern Canada, and also the percent of area in each flow range for the conterminous United States and southern Canada. The ***combination bar/line graph*** shows the percent departure of the total mean from the total median flow (1951-80) and the cumulative departure from median (in cfs) for all reporting stations (excluding eight large river stations indicated by * in the ***Flow of large rivers*** table) in the conterminous United States and southern Canada.

The comparative data are obtained by ranking the 30 flows for each month of the reference period in order of decreasing magnitude—the highest flow is given a ranking of 1 and the lowest flow is given a ranking of 30. Quartiles (25-percent points) are computed by averaging the 7th and 8th highest flows (upper quartile), 15th and 16th highest flows (middle quartile and median), and the 23rd and 24th highest flows (lower quartile). The upper and lower quartiles set off the highest and lowest 25 percent of flows, respectively, for the reference period. The median (middle quartile) is the middle value by definition. For the reference period, 50 percent of the flows are greater than the median, 50 percent are less than the median, 50 percent are between the upper and lower quartiles (in the normal range), 25 percent are greater than the upper quartile (above normal), and 25 percent are less than the lower quartile (below normal). Flow for the current month is then classified as: in the ***above-normal range*** if it is greater than the upper quartile, in the ***normal range*** if it is between the upper and lower quartiles, and in the ***below-normal range*** if it is less than the lower quartile. Change in flow from the previous month to the current month is classified as ***seasonal*** if the change is in the same direction as the change in the median. If the change is in the opposite direction of the change in the median, the change is classified as ***contraseasonal*** (opposite to the seasonal change). For example: at a particular index station, the January median is greater than the December median; if flow for the current January increased from December (the previous month), the increase is seasonal; if flow for the current January decreased from December, the decrease is contraseasonal.

Flood frequency analyses define the relation of flood peak magnitude to probability of occurrence or recurrence interval. ***Probability of occurrence*** is the chance that a given flood magnitude will be exceeded in any one year. ***Recurrence interval*** is the reciprocal of probability of occurrence and is the average number of years between occurrences. For example, a flood having a probability of occurrence of 0.01 (1 percent) has a recurrence interval of 100 years. ***Recurrence intervals imply no regularity of occurrence***; a 100-year flood might be exceeded in consecutive years or it might not be exceeded in a 100-year period.

Statements about ***ground-water levels*** refer to conditions near the end of the month. The water level in each observation well is compared with average level for the end of the month determined from the entire period of record for that well. ***Changes in ground-water levels***, unless described otherwise, are from the end of the previous month to the end of the current month.

Dissolved solids and temperature data are given for five stream-sampling sites that are part of the National Stream Quality Accounting Network (NASQAN). ***Dissolved solids*** are minerals dissolved in water and usually consist predominately of silica and ions of calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulfate, chloride, and nitrate. ***Dissolved-solids discharge*** represents the total daily amount of dissolved minerals carried by the stream. ***Dissolved-solids concentrations*** are generally higher during periods of low streamflow, but the highest dissolved-solids discharges occur during periods of high streamflow because the total quantities of water, and therefore total load of dissolved minerals, are so much greater than at times of low flow.

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